Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXI. DECEMBER, 1921 No. 6

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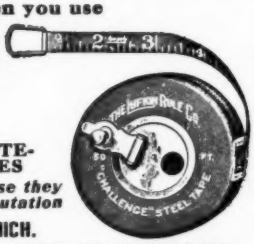

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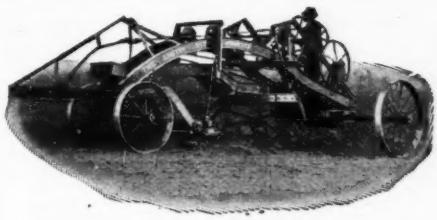

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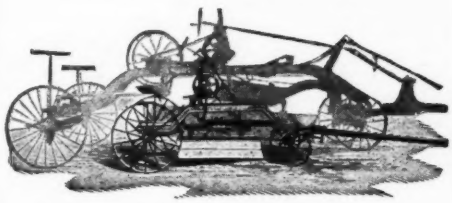

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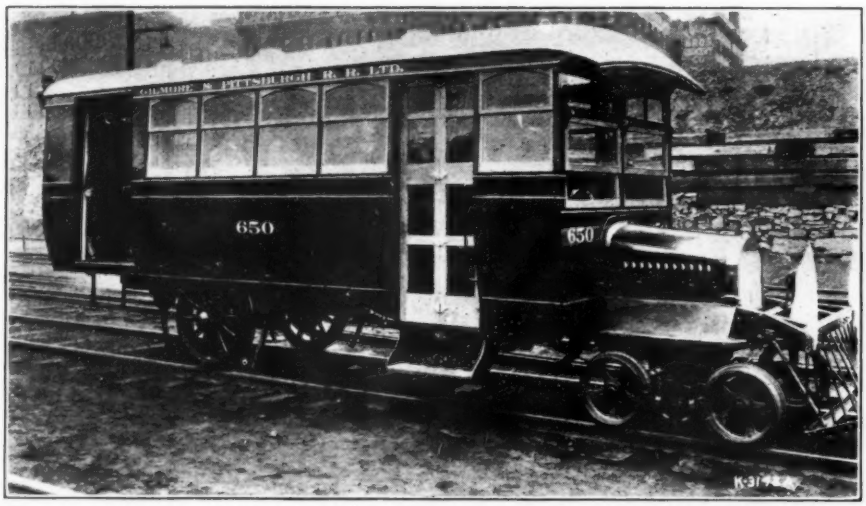
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



NEW TYPE OF GASOLINE RAIL CAR, MANUFACTURED BY THE INTERNATIONAL MOTOR CO., MAY REVOLUTIONIZE TRANSPORTATION ON SHORT LINES.

Motor Truck Operation and Accounting—76

TRUCK EARNS OWNER $2,000 IN 27 DAYS ON MINNESOTA ROAD WORK

By C. A. Harrington, 4200 Aldrich Ave., South, Minneapolis, Minn.

Two hundred and forty-eight (248) yard-miles a day is the record of my 3½-ton Acme truck. I purchased this truck in December, 1919, and have been using it pretty steadily on road building jobs, with occasional jobs of excavating. Most of my work has been in the State of Minnesota, and a great deal of it in the northern part, where we often work when the snow is on the ground.

During the 18 months I have had my truck, I have gone over 15,000 miles, averaging about 55 miles a day. On one road

ACME 3½-TON TRUCK AS OPERATED BY C. A. HARRINGTON ON MINNESOTA ROAD WORK.

building job I averaged over 80 miles a day for 4 months, and on one particular day I went 126 miles in 10 hours and hauled 248 yard-miles of gravel. The conditions were ideal on that occasion, as I had no waiting either to load or unload, and the roads were good. On that day I hauled 8 loads of 4 yds. each a distance of 7¾ miles.

As a general rule, road building is very hard on a truck. The season is short, so that the truck must work overtime and carry heavy overloads; and the roads are usually bad. I operate only about 180 days a year. The cost of operation, figured on the National Standard Truck Cost System, is $19.40 per day, including driver's wages. This gives me a cost of 34.83 cts. per mile. Actual repairs for the 18 months were $426, including an overhaul of the engine.

When working in the country on sandy roads, I get only about 2 miles per gallon of gasoline; on city jobs I have got as high as 6 miles per gallon. It all depends on the work, and the condition of the roads. A fair average for the 18 months is 3.75 miles per gallon of gas, and 140 miles per gallon of oil.

On the day when I hauled 248 yard-miles the cost of operation was:

Variable expense (126 miles @ 21.30c)	$26.84
Fixed expense (1 day)	2.19
Driver's wages (1 day)	5.50
Total expense for day	$34.53

That day I hauled about 32 yds., making the cost $1.08 a yard, and 14 cts. per yard-mile.

I have hauled as many as 12 loads of 4 yds, each a distance of about 2 miles, traveling about 50 miles during the day. The cost of operation on such a day is:

Variable expense (50 miles @ 21.30c)	$10.65
Fixed expense (1 day)	2.19
Driver's wages (1 day)	5.50
Total expense for day	$18.34

As the truck hauls 48 yds. of gravel, the cost is 38 cts. per yard, and 19 cts. per yard-mile.

Before buying my own Acme, I ran the first Acme dump body truck in this place, and I never heard of a truck of any make which hauled as many yard-miles per day as I did. In 27 days my total earnings with this truck were $2,640. Taking my present average cost of $19.40 per day as a basis, my profits were over $2,000. On the day I hauled 248 yard-miles I received 40 cts. per yard-mile. My earnings on that day were $99.20, and my profits $64.67.

The Acme truck has tremendous pulling power, and is built so strong that it stands the heavy strain of excavating work and road building very well. It has little difficulty in pulling out of bad grades in excavating work, or up heavy grades on road building work.

AVERAGE COST 3½-TON ACME TRUCK ON MINNESOTA ROAD WORK

Cost per Day (Including Driver)	$ 19.40
Cost per Mile	$ .3483
Total Cost for Period	$5,503.23

OPERATION	
Days Operated	278
Miles Traveled	15,800
Miles per Day	55
Miles per Gallons of Gas	3.75
Miles per Gallon of Oil	141

ITEMIZED COST	
Driver Cost per Day (Included Above)	$5.50
Depreciation per Mile	$ .0715
Maintenance and Repair, Actual, Total	$426.00
Maintenance and Repair, Actual, per Mile	$ .0269
Maintenance and Repair, Estimated, per Mile	$ .0269
Tire Cost, Estimated, per Mile	$ .0377

NEW GASOLINE CAR MAY REVOLUTIONIZE RAIL TRANSPORTATION ON BRANCH LINES

Fostered by the executives of the Northern Pacific Railroad in co-operation with W. F. Sailor, of the International Motor Company, several trial trips were recently made of a new type of passenger carrier which, it is said, may revolutionize rail transportation on branch line runs.

The vehicle which is arousing such unusual interest among leading railroad officials of the country, is a specially designed Mack gasoline rail car mounted on steel flange wheels so that it can be operated on standard railroad tracks.

The experimental trips were made over the Northern Pacific route from St. Paul to White Bear, a distance of about 12 miles. This run includes a steep and winding grade almost 2 miles long, one of the most severe in the Northwest. When it is understood that two locomotives are required to pull a passenger train up this ascent, some idea of the severity of the test may be ascertained.

Such great importance was attached to the first trip, that possibly the largest assemblage of big railroad men of the Northwest were present to take part in the initial tryout over the White Bear route. Prominent among these officials were Charles Donnelly, President of the Northern Pacific; Ralph Budd, President of the Great Northern; J. M. Hannaford, Vice Chairman of the Northern Pacific; W. T. Tyler, Vice President of the Northern Pacific; William Genlo, of the Minneapolis & St. Louis; A. R. Kipp, of the Soo Lines; W. L. Luce, President of the Electric Short Lines, and J. J. O'Neil, General Manager of the Chicago, St. Paul M. & O.

Twenty-three passengers were comfortably carried on the first trip, although the rated capacity of this motorized rail car is 17 persons in addition to a baggage compartment. The rail car, watched by a long line of autoists who had assembled along the route, quickly climbed the steep, curved incline, and completed the run of 12 miles to the entire satisfaction of every one of the railroad officials.

After enthusiastically discussing the performance they had just witnessed, their unanimous opinion was that the experiment proved beyond a doubt that motorized carriers, properly equipped, can be used to profitable advantage in certain phases of railroad service.

When a second trip over the same route was made a few days later, the distance was covered in 29½ minutes, only 4½ minutes longer than it takes the Duluth Limited to make this run. Obviously, a small motor bus could not be expected to save time when competing with steam equipment, yet the railroad men who have carefully considered operating costs, strongly believe that gasoline rail cars will effect a more vitally necessary saving —that of operating expense. Moreover, even under the most unfavorable conditions for running a gasoline car, it has been found that the costs are much lower than those of steam operated equipment. This saving in operating costs, combined with the comparatively small capital investment required, promises to be the salvation of many branch lines, some of which have to discontinue service or will soon be compelled to do so because the expense of operating steam equipment far exceeds the revenues obtainable for the service rendered.

One of the results of these tests has been a radical step away from established railroad precedent recently taken by the Northern Pacific. A number of years ago when James J. Hill, one of the foremost railroad men of his time, ran his first locomotive out of St. Paul, steam equipment was looked upon throughout the country as being the only logical answer to the transportation problem of the rapidly expanding Northwest. Today, his successor, Charles Donnelly, the present head of the Northern Pacific, is turning to the gasoline engine as an economical solution to one form of this transportation problem—short haul passenger traffic—which has never been profitably solved by the conventional railroad equipment. Convinced of the advantages of gasoline motor cars, the Northern Pacific now operates a Mack mail car in regular service on a branch line, and expects shortly to install more of these cars in like and larger capacities. Another big railroad of the West, the Great Northern, is also

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Capacities 1½ to 7½ tons. Tractors to 15 tons

INTERNATIONAL MOTOR COMPANY, NEW YORK

"PERFORMANCE COUNTS"

planning to install gas-propelled rail cars on its various branch lines.

In the East the New York, New Haven and Hartford R. R. will soon operate 3 such rail cars. Many of the smaller railroads, such as the Narragansett Pier R. R., Aberdeen & Rockfish R. R., Sewell Valley R. R. and Stone Harbor R. R. have been successfully using motor equipment for some time.

THE 1922 ROAD SHOW

Extended discussion by noted highway engineers from all parts of the United States and Canada relative to design, methods and materials used in modern highway construction will form a large part of the program of the American Good Roads Congress, to be held at the Coliseum, Chicago, Ill., on Jan. 17-20, 1922, under the auspices of the American Road Builders' Association ,the oldest and largest organization of its kind in the country.

Three of the 8 sessions of the Congress will be devoted to a discussion of new methods used in building asphalt, concrete, brick and other modern pavements. The economical construction and maintenance of the cheaper types, such as waterbound macadam, sand-clay, gravel and earth roads, which constitute nearly 90 per cent of the 2,273,131 miles of highways in the United States, will also be discussed.

One session of the Congress will be given over to the consideration of problems of highway finance and administration. Because of the high interest rates now prevailing on road bonds, approximately 10 per cent has been added to the cost of road construction from this source alone. Increased freight rates have added a like amount. Since many states are fast approaching their permissible bonded debt limit, the methods of raising and expending road funds are becoming vastly important and road officials are bending all their energies toward securing greatest returns for expenditures.

Invitations to the Congress are being sent to nearly 30,000 federal, state, county and city officials, contractors, engineers and business men in the United States and Canada. It is expected that the attendance will greatly surpass the record set last year and that the Congress will develop a clearer understanding of diverse highway problems, so road officials may, in spending their funds, secure "more roads for less money."

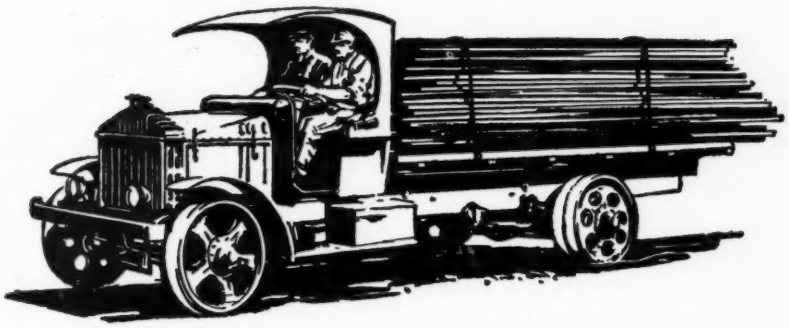
No less important will be the National Good Roads Show to be held at the Coliseum in conjunction with the Congress. This show will contain close to $1,500,000 worth of labor-saving road machinery appliances and materials and highway transport equipment. At the October drawing for exhibition space the entire 40,000 sq. ft. of available space in the Coliseum and Annex was taken, necessitating the lease of additional buildings to care for the manufacturers now applying for room.

The use of labor-saving machinery during the past few years has revolutionized road construction methods and the coming show will offer an opportunity to all persons interested in road work to see in actual operation the most recent mechanical developments in the field. More than $100,000,000 worth of road machinery is being manufactured annually, a sum greater than the combined value of all other construction machinery produced. The machinery and material manufacturers with exhibits will have special representatives at the show to explain their machinery and paving materials.

The annual meeting and "get-together" dinner of the American Road Builders' Association was held at the Automobile Club of America, New York City, on Nov. 15. Following the session of the board of directors at 3 p. m., the annual meeting of the members of the association was held, at which the reports of the officers and committees were received. Officers for the ensuing year were elected as follows:

President, H. L. Bowlby, Chief of the War Materials Division, U. S. Bureau of Public Roads; vice-presidents, Charles J. Bennett, State Highway Commissioner of Connecticut, New Haven, Conn.; Frank Page, Chairman, North Carolina State Highway Commission, Raleigh, N. C.; A. R. Hirst, State Highway Engineer of Wisconsin, Madison, Wis.; W. W. Crosby, National Park Service, Estes Park, Colo.; Secretary, E. L. Powers, Editor, "Good Roads," New York, N. Y.; Treasurer, Senator James H. MacDonald, former State Highway Commissioner of Connecticut, New Haven, Conn.

Several changes to the constitution and by-laws of the association were approved, the most important being a change in the date of the annual meeting from November to May and a change in the method of electing officers. Under the new provisions officers will be elected from among the directors by the directors. Vacancies on the board will be filled each year by a nominating committee of seven selected



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They carry maximum effective loads and are always ready for service. They can be easily run with the least wear and strain.

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3½-ton 4350
5 - ton 4850

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THE PIERCE-ARROW MOTOR CAR COMPANY, BUFFALO, N. Y.

from the board of directors. Another change makes the president eligible for re-election. By holding the annual meeting in May the new officers will have a longer time in which to lay plans for the annual convention and exposition.

The amount of money now being expended on highway construction is greater than that being spent on all other public works combined. The value of road machinery now being manufactured exceeds the total value of all other construction machinery being produced. More than one billion dollars is available in the United States for road construction.

In view of these facts, it follows that the coming convention and good roads show will be the event of the year for highway officials, engineers and contractors, automotive engineers and manufacturers, and persons interested in highway transportation and highway finance. With the present great interest in road matters and because of the central location of Chicago and the excellent facilities offered by that city, the officers of the association are confident that the attendance of members and delegates will surpass even the record attendance at the convention held in Chicago last year.

FACTORS INFLUENCING STREET DESIGN

By P. L. Brockway, City Engineer, City Hall, Wichita, Kansas

Streets should be of five types so far as design is concerned: Park drives, tertiary streets, secondary streets, primary streets and broad boulevards.

Park Drives

First: Informal drives, principally through parks and playgrounds winding here and there to reach vantage points for pleasure driving only; scarcely to be given the dignity of being called streets at all and yet merging into the street system. These do not ordinarily need to be wider than sufficient to provide for two lines of traffic as there is no reason for parking on them and the class of vehicles using them can and should be restricted to those driven for pleasure only. They should be so located as not to invite through traffic even of this class in order to keep them set apart for their intended use. The width which appears to be most economical and still satisfactory is about 20 feet. This gives plenty of room for two lines of traffic without creating an uneasy subconscious impression of being crowded, in the minds of the drivers, and so detracting from the chief business at hand, that of enjoyment.

As to the character of the improvement of the drive, much will depend on the local conditions as to availability of different materials, character of the subsoil, drainage, etc., but the surface most in keeping would be the one which harmonizes best with surroundings, a mixture of gravel and clay well kept up, would be in order almost anywhere but especially so in hilly wooded country. In level localities, where dependence is placed mainly on sodded lawns and group planting of shrubs and trees, the light colored surface of concrete or asphalt mixtures makes a pleasing contrast. Many drives of this kind are, of course, water-bound macadam, or penetration macadam, or oiled roads. The water-bound macadam is objectionable on account of dust. Penetration macadam and oiled roads require considerable maintenance under the impact of the heavy automobiles now in common use.

There should be only the least possible crown, necessary for drainage, depending on the type of surface and no curb whatever.

In gravel or oiled roads, a narrow stone gutter along each edge is advantageous in that it gives a finished appearance which is not possible if the sod is allowed to overlap the edges of the road. It also gives a guide line to follow in driving over the road which adds to the subconscious ease of driving.

We have a drive of this sort two miles in length, completed this last season, which is 20 ft. wide over all, with a monolithic gutter 2 ft. in width on each side depressed 1 in. in the center of the 2 ft. to carry water to suitable outlets and with a 16 ft. width of asphaltic concrete surface crowned 2 ins. in the 16 ft. The inner edge of the concrete is a big help in driving as a guide line and the driveway as a whole has received much favorable comment from landscape engineers. It was purposely laid out without any tangents either horizontal or vertical in order to contrast with our monotonous straight streets and flat uniform grades, being built in sand dunes along a river bank.

Tertiary Streets

Tertiary streets, which would not find much use except in rather rough country or isolated nooks or odd corners occurring in the development of a combination

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

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of rectangular and radial system of major streets, form the second type. These could be very effectively used in such localities. They should necessarily be short and, if blind at one end, should be provided with a turning loop which could enclose a small landscape planting or fountain and fish and lily pond. A narrow width of surfaced driveway would be necessary in order to be in keeping with the short length of the street, and because of the limited territory served, a width sufficient for a moving vehicle to pass one parked on the street would be sufficient.

These conditions would seem to be fully met by a 20 ft. roadway. The street need not be straight, in fact, if topography were suitable, curves would add to the apparent privacy and exclusiveness. Some courts of this sort have been platted without being formally dedicated as public streets at all, but rather handled by deeding an undivided interest with each building site.

The location of sidewalks, wherever possible, should be far enough back of the curb to permit group planting of shrubbery between them to enhance the sylvan effect. This would not always be possible on account of space and not desirable where the street is joined at both ends with busy thoroughfares. Although probably every city has a few such, and it is never satisfactory to make the street as a whole so narrow that it is necessary to place the walk immediately behind the curb, except of course, in business streets.

The two chief reasons for separating the walk from the curb are that it places pedestrians too close to moving vehicles in wet weather and that it is practically impossible to cross the sidewalk with a driveway from the street without inconvenience, or even danger to both vehicles and pedestrians.

If the sidewalk is separated at all from the curb it should be far enough to give a well balanced planting space between the two, at least twice as wide as the walk and preferably not less than 10 ft. On the type of street under discussion a 4 ft. walk will probably be wide enough. This would require a minimum street width of 20 ft. roadway, two 10 ft. planting strips and two 4 ft. walks, or 48 ft. This would, of course, not always be possible. It could be narrowed to 34 ft. by placing a sidewalk on one side only depending on the location and use of the street.

We have recently improved some streets of the public court character entirely out of line of through traffic and at my suggestion, they were paved only 20 ft. wide with fairly long radii or curbs at street intersections. The parkings have had good plantings and the whole effect is that of a prosperous country place with houses back in the woods.

I have suggested in a very narrow street with walks necessary on both sides, that the curb be omitted and replaced with a gutter sloping up from the pavement 4 ins. in 2 ft. to the usual walk so that a car could cross it anywhere at any angle and the walk would still be separated from the pavement and have no break in the surface. I do not think that arrangement is desirable but I do believe it would be better than cutting a wide driveway through the walk at practically every 50 ft. building site as will be necessary in the block in question. There is a 3 per cent grade in the block so that there would be practically no danger of street water flooding the walk. My suggestion fell on deaf ears because it was "different."

Concerning slopes on the planting strip in this type of street, it would seem to be rather immaterial just so there is sufficient slope for drainage on account of the informal character of the whole layout, excepting that it should be considered as a part of the treatment of the whole layout from the landscape viewpoint. Some regard would have to be given to the grade of driveways, which would also depend on the slope of the lots themselves.

Secondary Streets

Secondary streets serving local districts and acting as feeders to the major street system, form the third type. These would naturally be more formal, follow more direct lines and require entirely different treatment than those already discussed. They would not, and should not entirely disregard topography as is so often done. In choppy, hilly country they should in general, follow the lowest ground as far as possible leaving the interior of large blocks to be reached by the tertiary streets.

If the drainage area is large so that a street at the foot of two hills would too easily flood, it might be desirable to place a street on each side of the lowest ground, treating the space between as a sunken garden with appropriate planting.

Of course if the hillside slopes are long there will be required other streets than

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those at the foot. These should be so located as to avoid excessively steep grades. Very pleasing effects may be obtained in rolling country if vertical curves are carefully worked out in long straight streets.

I have sometimes found it necessary to run vertical curves of the third degree making the rate of the change in grade uniform. In such cases grades must be established fairly close together and care must be used to avoid angles due to careless construction. Nothing is more pleasing than curved roadways, either vertical or horizontal, if the construction work is well done or more displeasing than a careless attempt to do the same thing.

Concrete curbs lend themselves readily to this class of work as forms can be lined up far enough in advance of finished work to avoid irregularities. In establishing grades on side hills, it is generally best to favor the lots on the low side as it is much cheaper to shape up and maintain a terrace or series of terraces on the high side than to fill up the rear end of the low lots. The planting space between the curb and walk on the high side should be much steeper than that on the low side in order to prevent as far as possible the optical illusion that the high side is the lowest. This is also helped by building the pavement with an eccentric crown.

In flat, featureless country, the rectangular system of platting is probably best for secondary streets as there is less waste ground. The only landscape treatment of much value in that case is that of giving long vistas and in order to give proper breadth the building line should be well back from the street and group planting of shrubs should not be allowed too far out from the building line.

The width of roadway in secondary streets should be sufficient for three lines of traffic including vehicles parked against the curb. There is some difference of opinion on this point. Nearly everyone is agreed that 10 ft. should be allowed for the first line, after that, recommended widths for the second and third line range from 8 to 10 ft., making the total roadway 26, 28, or 30 ft. On account of the wandering habits of ice wagons and the rather serious blocking of streets by moving vans backed up to the curb together with the much greater ease of turning a car, having a long wheel base, into private driveways, our own practice is to recommend the 30 ft. roadway although we do not refuse to improve with a 26 ft. width.

The width of the planting strip between the curb and sidewalk should also be about 10 ft. in order to give a well balanced appearance to the street. This is about the least width which will support a large tree without crowding one side or the other and it would seem to be rather an essential part of the improvement of this type of street to provide for rows of stately trees, furnishing pleasing vistas. Sidewalks on this type street should be wide enough to allow one person to pass two without crowding. This will require a width of not less than 5 ft.

The total width of street on this basis will be pavement 26 to 30 ft, planting strips, 20 ft., sidewalks, 10 ft., or a total of 56 to 60 ft.

Long Radius Curves at Intersections

One detail in street design which has come into rather considerable importance in the past ten years is the length of the radius of curbs at street intersections. When horse drawn vehicles were the only kind in use, short radii were the rule and were generally satisfactory but with the present traffic, the radius should never be less than 10 ft. and from that on up to anything in reason. Some states prohibit a radius longer than the width of the least parking at a street intersection on account of some vested rights which are supposed to rest with the owner of the abutting lots. This detail furnishes another reason for making the planting strips 10 ft. in width, because if the curve begins very far back of the sidewalk there results an awkward angle where the intersecting walk joins the curb. In passing, it might be remarked that this is no cure-all, as there have been five serious accidents, in as many weeks at an intersection of a major street, having a 40-ft. roadway, with a secondary street, having a 30-ft. roadway, with curbs of 20-ft. radii on all four corners and buildings far enough back to give fair visibility in all directions.

Surface Drainage in Flat Cities

Another troublesome street detail is the matter of drainage in the absence of storm sewers. This may seem a contradictory condition to engineers working in some cities. It is, however, a fact that, in some very flat cities where storm water tends to spread out rather than flood low points, adequate storm sewers are the last improvements the public can be persuaded to buy. There must therefore be some means provided for surface drainage in paved intersections. Three methods may be employed. First: Construct an inlet

and outlet on two corners in the direction of flow and connect with an inverted syphon. This is continually silting up on account of sluggish flow and is a constant nuisance. Second: Construct a box culvert in the pavement in the direction of flow. This gives one of two results, either the box is so small as to be constantly choked up, or else the gutters must be depressed so low to give adequate entrance to the culvert that the result is an unsightly and even dangerous corner. I have in mind one thriving little city with curbs uniformly over 18 in. high on this account; it gives one the impression that the whole city is walking on stilts. Third: Depress the surface of the pavement to the elevation of the gutters in the line of flow. This is the surest method of disposing of the water in any kind of storm, but unless handled carefully is very objectionable to vehicular traffic. We have adopted as a standard change in grade in the approaches to the open gutter, 3 ft. distance for each inch of total crown. These slopes do not make an abrupt ditch at their intersection and are not at all objectionable to any type of motor car traveling at any reasonable speed. We have not, however, used this type on streets of our next classification, preferring generally the inverted syphon.

Primary Streets

Streets included in the major or primary thoroughfares constitute the fourth type. These streets to be located primarily for one purpose, to facilitate the movement of all sorts of street traffic to the various centers, from each other, and from the residence and suburban districts and from the surrounding country. To gain this purpose they should be as direct as possible both horizontally and vertically, which would mean that they could not entirely disregard topography and natural obstacles, but that, depending on the traffic requirements and the wealth of tributary territory, considerable money might be spent in reducing grades or bridging rivers in order to obtain more direct routes. In fact, increased traffic concentration in some of the larger cities makes almost imperative the expenditure of vast sums not only to overcome natural but also artificial obstacles.

There could scarcely be any fixed rule as to the location of such streets, beyond the statement already made. Each city presents an individual problem as to its general traffic movement and would have to be so treated. In fact, it would seem wise rather to emphasize this fact in order to give the city individuality.

As to the width of these thoroughfares, this would require individual study of traffic flow, its past, present, growth, and probable future. It would not seem wise, however, to provide for less than four lines of traffic if the street is at all important, which under the rules already mentioned would require a roadway of 34 to 38 ft., tending toward the latter on account of the higher speed of part of the traffic. Streets containing street railway tracks should be just as much wider than these figures indicate, as the space required for clearance of the street cars, probably 18 ft. more in streets having double tracks as the tracks should not be permitted to be so spaced that a person could not walk between them without being "rolled" to death. This would make a total width of roadway of 56 ft. in this case. To residents of many cities this will doubtless seem a waste of ground, but it is quite common and often exceeded in many western cities.

Traffic counts may be misleading unless all the facts are known. If cars uniformly spaced on 100-ft. centers and traveling at 20 miles per hour, passed a given point 1,056 would be counted in a single line of traffic. This could scarcely be realized in actual traffic conditions, especially on city streets on account of interference of cross traffic. For example, a recent traffic count on a street containing a double street car line and of 50-ft. roadway where there was very little interference of cross traffic for 1,000 ft. in either direction showed that over a thousand pleasure cars in addition to a third as many more slower moving vehicles were passing each hour. There was no crowding or confusion and twice as much traffic could have been easily accommodated. Another count on the same street of the same effective width, but with probably half as much cross traffic at each intersecting street showed very little more traffic but constant congestion and delays.

This point is brought out only to emphasize the fact that each street will require individual treatment and different treatment in different places according to local conditions.

Thoroughfares of 38-ft. roadway should have planting strips not less than 15 ft. in width in order to appear well balanced and to insure greater range of vision at intersecting streets. Walks should ordinarily be wide enough to accommodate three abreast; 6 ft., making the total

street width 80 ft. Another point in favor of this minimum total width is that, as the business section follows out along the street, the planting strip can be eliminated and the roadway and sidewalks widened to cover it, the relative widening depending on the relative importance of the two types of traffic. It is likely, however, that with this total width the walks should not be less than 12 ft., nor more than 15 ft. on each side. With this ultimate improvement in mind, it would seem highly desirable to fix the cross section of the street as a whole in a rather rigid, formal manner in order to avoid confusion and expense of changing walk elevations later.

Eighty feet is indicated as the minimum desirable width for a really important thoroughfare and, while probably sufficient for most streets, should be increased in important business thoroughfares carrying both local and through traffic to such a degree as to avoid needless delay or else alternate routes provided. This latter course is often the simplest and best way out of a serious dilemma on account of prohibitive cost of moving or cutting fronts from existing buildings. As an extreme measure the front portion of the lower floors of business buildings have been set back, using the space so gained as an arcade and occupying the whole of the original street for vehicles. This is most undesirable and should be employed only as a last resort. However, volumes could be, and have been, written on this particular branch of street design and still each problem is peculiar to itself.

We have used a somewhat different plan in widening roadways from that ordinarily recommended. Certain streets were required to be widened on account of change from residence to business use before the original pavement was worn sufficiently to justify its removal. The crown of the original pavement was also excessive, so that if continued for additional width, it would require an excessively high curb and the ultimate destruction of the whole pavement to make a satisfactory trafficway. Therefore the only change made included the removal of the curbs to the new lines and the construction of pavement in the intervening strips, but with the new portions sloping down toward the original gutter line. This permitted the curb to be set higher to fit existing walks which, of course, sloped down away from the building line, and still have only a reasonable height showing above the pavement. It will be possible also when the surface of the original pavement must be renewed to build up over the old gutter line with new concrete and have a crown of reasonable height and contour over the street as a whole without destroying the base.

Another very satisfactory detail was that of the driveway entrances to certain garages in the block. The driveway approaches were built practically entirely in front of the curb for a distance of about 4 ft. and with easy approach grades at each side. These do not interfere with walk or street traffic either to any objectionable degree. I have thought, in fact, that this might be the best street contour for auto rows or other streets with no planting strips and many driveways across the walks.

Curb heights vary, but most localities use 6 to 8 ins. The best practice would indicate a height which would not be inconvenient to step over, especially in business streets. It is also desirable to raise the gutters up to the top of the curbs at all sidewalk crossings in order to avoid any stepping up and down whatever and, of course, there should be no open, uncovered openings to step across. This detail is easily arranged by raising the elevation of the whole intersection and depressing the gutters for a short distance at the corners of the intersecting walks. This corner depression also serves to keep vehicles off the sidewalk. Adequate storm sewers are necessary with plenty of inlets at all corners toward which there is any surface drainage. Sidewalk slopes of about 1 ft. drop to 40 ft. width are most satisfactory and are fairly representative of standard practice.

Broad Boulevards

Broad formal boulevards designed primarily as pleasure drives with wide vistas and elaborate landscape treatment, often terminated at a monumental civic center or outstanding natural feature of the city constitute the fifth type.

The design may include two or three or even more separate roadways divided by gardens and lawns. In any event so much is involved in the successful design and maintenance of such a project that it should be undertaken only by landscape engineers and architects, of wide experience.

The foregoing paper by Mr. Brockway was presented before the 1921 convention of the American Society for Municipal Improvements.

EDITORIAL

CENTRALIZED MUNICIPAL PURCHASING

The centralization of governmental purchasing is a development of recent years which has much to commend it. Today not only many departments of the federal government, but also many state, city and county governments, maintain departments of public purchase. The movement is right in principle, has succeeded where tried and is growing.

Centralized purchasing is advantageous, in the long run, both to the buyer and to the seller. For some years the city of Indianapolis has maintained a Department of Public Purchase and the experiences of this department serve well to illustrate the advantages of centralized municipal purchasing. The primary duties of the department are: To buy all materials, supplies and equipment for all other city departments; to arrange for all repairs to buildings or equipment; and to sell all obsolete material or equipment after proper appraisal. Requisitions are received by the department from 40 sources and cover everything from pins to motor trucks. Figures on the activities of the department for the past four years are instructive. The number of requisitions received has ranged from 6,827 in 1921 to 8,500 in 1919, and the number of orders placed from 9,273 in 1920 to 9,954 in 1919. The annual volume of business transacted by the department has ranged from $732,027 in 1918 to $1,284,409 in 1921, while the cost of maintaining the department has ranged from $8,935 in 1918 to $13,525 in 1920. The percent of the cost of the department of the business it has done for the past four years has been 1. 2, 1.2, 1.1 and 1.05, respectively. It is stated that the department saves the city $100,000 per year as compared with the old method of buying.

During the 4-year period under discussion the department has been directed by D. S. Ritter as City Purchasing Agent. He has spent nearly a score of years in purchasing work, mostly in the service of large private business corporations. His views on the advantages, from the standpoint of the public, of centralized city purchasing, at the close of his term of office, are therefore of immediate interest and permanent value to all who are working for greater honesty, efficiency and economy in city government. He states these advantages substantially as follows:

It creates an organization of specialists on purchasing, who give full time to studying the needs of the city and the market conditions for supplying those needs; it is the only way to collect a complete set of records as to materials bought by the city and services rendered to it; by issuing a written order for every obligation incurred, the purchasing department enables the treasurer to check expenditures with expected income closely and frequently; it promotes standardization of materials used by various departments; it develops proper specifications for articles needed; it reduces the city purchasing expense; it eliminates verbal orders and no records; it buys the same materials for less money; it curbs extravagance; it collects and distributes valuable information and advice; it exchanges material between departments; it sells material when entirely useless for any department; it promotes quantity purchases of standardized articles; its trained inspection prevents the acceptance of materials not up to quality ordered; good work in this office especially commends an administration to the people; as the department deals in almost every class of material, it is in position to give advice to all the people as to price tendencies; and, last, but not least, it eliminates political influences.

This is an impressive list of advantages and in a properly administered office one may readily believe that they will all be realized. There are at least two disadvantages which may arise unless such a department is conducted with common sense and discretion. The temptation to compile voluminous and hair-splitting specifications is too great for some purchasing agents to resist. We believe that, in general, it is better to have general requirements, with which the merits of things on the open market may be easily tested, rather than to have such elaborate specifications that they frighten the seller away or force him to change his products or his processes before he is admitted to competition. The latter course destroys much, or all, of the economy possible in governmental purchasing. Purchasing agents, it seems to us, will do

well to confine their efforts largely to the proper selection of goods on the market, without undertaking to remake the manufacturing world over night. The other disadvantage to which reference was made is the temptation to be too much influenced by price at the expense of suitability, but perhaps other departments can be depended upon, in preparing their requirements, to make sure that price is not accorded too much weight.

So far we have considered only the viewpoint of the public, but we fancy that the seller also derives some real advantages in dealing with a local government purchasing department. Such a department centers all want lists in one office, gives all salesmen the same information as to what is needed, enables the seller to file all his invoices in one office, furnishes a place where he can get all information as to the condition of his account, and opens an easy way for him to present new materials or equipment so they can have consideration for use wherever needed.

We have said that the centralized municipal purchasing plan is growing in favor; we should make clear also that it is already an established success in such cities as: Atlanta, Dayton, Portland (Ore.), Milwaukee, Memphis, Syracuse, Boston, New York, St. Louis, Philadelphia, Denver, Detroit, Rochester, Grand Rapids (Mich.), Salt Lake City, Kansas City, Des Moines, Pittsburgh, Baltimore, Dubuque, Cincinnati, Louisville, Columbus (O.), Cleveland, Los Angeles, Logansport (Ind.), Oakland (Calif.), Indianapolis, Patterson (N. J.), Dallas, New Orleans, Birmingham, Galveston, and Highland Park (Mich.).

As many of our readers doubtless know, there has been in existence for some years a large and active organization known as the National Association of Purchasing Agents. Naturally many of the purchasing agents in governmental service are members of this association. At the 1921 convention of the association a resolution was adopted enumerating certain essential points to be safeguarded in order to establish central governmental purchasing and to make the work efficient. The resolution was formulated because "centralized purchasing for city, county and state governments has proved its value to many localities and their experience is being sought by others." The substance of the recommendations follows:

The department must be independent and accountable only to chief executive; funds for its support should be included in the tax levy. The purchasing agent should be selected with respect to his experience, ability and integrity; he should hold office during satisfactory performance and be removed only on proof of written charges of official misconduct. He should select his own assistants and call meetings of representatives of each executive department to standardize supplies and equipment and prepare proper specifications for describing these standard articles. These standard articles should be bought in proper quantities and kept in a central storehouse maintained by a rotary stores fund and managed by the purchasing department. The department should furnish all materials upon receipt of requisitions describing articles needed and signed by authorized officers, and should have authority to call for requisitions when, in its judgment, conditions of business justify. Purchases should be made at the lowest prices consistent with quality and service. The department should contract for repairs, when needed, to any buildings, equipment or material belonging to any department when that department deems such repairs necessary. All obsolete material should be disposed of when returned to the storehouse. The storekeeper should receive and inspect all materials and make daily reports of all receipts and disposals. The purchasing department should receive invoices from vender, and when they are found to conform with material delivered as to price, quantity and quality, should be vouchered to the finance department for payment from the rotary stores fund. Finally, all records of the purchasing department should be open to public inspection.

There has long been much discussion of putting public business on a "business basis," meaning, of course, on the same basis as private business. For those who sincerely desire such a reform it may well begin with the centralized purchasing of all equipment, materials and other supplies paid for directly out of the public treasury.

In closing this discussion we wish to emphasize our belief, based on conversations with many "supply men," that the cleaner and more businesslike public business can be made the more attractive they will find it. A city that is known to make its purchases on a square basis gets the benefit of all the good, sound competition the country affords. We decline to state the devastating alternative.

FEATURES OF STATE HIGHWAY WORK IN MONTANA

By John N. Edy, Chief Engineer, Montana Highway Commission, Helena, Mont.

Increased Federal Aid

It is by no means certain that Montana can match Federal funds made available to it under the provisions of recently enacted Federal legislation. While all the terms of the new law are not fully known to the department at this time it is understood that Montana's share of the new Federal appropriation will approximate one and one-half million dollars, approximately $500,000 of which is immediately available. The report of the State Highway Department for the month ending November 15 shows that, of Federal funds apportioned to Montana under the 1916 and 1919 Acts of Congress, Montana has yet to match approximately one and one-half million dollars. This amount together with the one-half million dollars immediately available from the 1921 appropriation represents approximately four million dollars worth of work which the department could undertake at once if the local share of the cost could be financed.

Working for a State Bond Issue

In the fall of 1919 Montana counties voted road bonds in total amounts of approximately six million dollars and very much of this money was used in matching Federal funds. However, it appears that many of the counties have reached the limit of their ability to bond for this purpose and the only possibility of covering Federal funds now apportioned to Montana seems to be through a state road bond issue. The State Highway Department has already made public announcement of this fact. Not only will the department support a state bond issue for road improvements but it has already indicated its intention actively to promote and encourage such an issue. It is now believed that a road bond issue bill will be initiated early in the coming spring in order that the matter can be submitted to the voters at the general election in November, 1922. While the details of the bill have not been worked out it is practically certain that the ultimate source of revenue will be an increase in motor vehicle license fees.

Highway Maintenance

The problem which is giving the state highway department considerable concern at this time has to do with the proper maintenance of road improvements already built under its direction. The Act creating the state highway commission authorizes it to take over the maintenance of state highways; but inasmuch as the fund provided for administrative purposes is not sufficient to carry the added burden, it has been necessary to depend upon the counties for maintenance, and this plan has not been generally satisfactory.

An effort is now being made to secure the more active co-operation of counties in the adoption of a suggested and definite form of maintenance organization and practice, particularly in respect to Federal aid road improvement in the various counties. As one manner of state aid the department proposes to purchase and place in operation a number of rock crushers by means of which additional fine wearing surface material will be made available for early spring maintenance use. The department has adopted the gravel surfaced road as representing the most desirable and economical type of improvement for the state highway's system under all prevailing conditions, and by the close of this year will have completed approximately 750 miles of such work.

Highway Standards

While the state highway department of Montana has concentrated its efforts upon the construction of a large mileage of gravel surfaced roads, it has always been felt that because of the possibility of further development of a portion of this mileage, some value of the gravel surface might be lost. However, in the light of the experience of this and other states, it is now believed that the policy of constructing gravel roads fits in admirably with any policy of future development that might be dictated by traffic demands. It is now conceded that there is a place in the state's road program for the construction of bituminous wearing surface upon a black base, over a well-compacted gravel or macadam sub-base. Furthermore, the practice of the department in the future will not permit the placing of concrete pavements directly upon gumbo or adobe soils, but under such conditions will require a well-compacted gravel sub-base. Montana's standard paved road sections now include only Portland cement concrete and bituminous concrete upon a 6-in. concrete base. It is proposed to admit in competition with these types the bituminous concrete wearing surface upon plant mixed black base, as above described, when foundation conditions seem to justify.

Co-operation with Engineering College of State University

The engineering staff of the state high-

way department is co-operating with the State College of Engineering in a manner more or less unique, but which gives promise of beneficial results for both the department and the college. Arrangements have been made whereby responsible members of the department's engineering staff will deliver a series of 14 lectures at the college during the winter session. The subjects that will be discussed are live and practical, the object being to put the engineering student, and particularly those nearing the end of their college work, in close and intimate touch with the problems confronting the state road authorities. While the ultimate outcome of the plan is yet to be determined, both the engineering college and the state highway department anticipate that material benefit will result.

PAVING BRICK VARIETIES REDUCED TO ELEVEN STANDARD SIZES

(Editor's Note: Wishing to get the manufacturer's point of view as to the results of the conference of the U. S. Department of Commerce on Simplification of Variety and Standards for Vitrified Paving Brick, held in Washington, D. C., on November 15th, we asked the Secretary of the National Paving Brick Manufacturers' Association and he wrote us the following letter:)

To the Editor:

There are two phases of the recent conference in Washington that seem to grow clearer in retrospect.

The first phase seemed very desirable and advantageous in advance of the meeting and since it has become an accomplished fact it has become very important. I refer to the actual elimination of varieties that were recommended. Paving brick varieties are now reduced to 11 by mutual consent of engineers and manufacturers and it is difficult to imagine any paving situation in which brick might be considered that cannot be satisfied by one of the remaining 11 standard varieties.

In addition to the action of the meeting as above indicated, a permanent committee was established to recommend further eliminations as might seem wise.

The second big result of the conference as it appears in retrospect is the fact that it demonstrated, I believe to the satisfaction of everyone present. that engineers and manufacturers can find satisfactory working bases if everyone would discuss with each other matters of fact.

Not the least of the results of the conference, therefore, as it appears to us, is that the conference has demonstrated that relations between producer and consumer, where on the one hand the producer has an organization and on the other the consumer is represented by strong organizations such as the engineers have, can be harmonized by mutual consent.

You appreciate the fact of course that the conference was held in the atmosphere of public interest as expressed by Mr. Hoover. We believe thoroughly that a new relation has been established between the producers and their market.

As a matter of actual operation, it is our hope that the constituent engineers of the conference will look to the conference for policy in respect to brick pavement specifications.

The permanent committee, it seems to us, is something like a supreme court—empowered not only by common consent to decide questions as to variety, but likewise to make such investigations as in its judgment are necessary to shed light on any question which might hereafter assume any of the characteristics of a disputed point in relation to variety.

I believe you can appreciate why we feel that we owe a great deal to Mr. Hoover, the U. S. Chamber of Commerce, through its Fabricated Production Department, and the engineers who were kind enough to attend the conference, all of whom aided in the splendid results obtained.

Very truly yours,

MAURICE B. GREENOUGH,
Secretary.

National Paving Brick Manufacturers' Association, Cleveland, Ohio, Nov. 19, 1921.

GREAT WORKS IN PROSPECT IN CITIES OF WESTERN EUROPE

To the Editor:

I have completed a 6 months' trip through England, France, Belgium, Holland, Germany, Czechoslovakia, Austria, Switzerland and Italy, where I have been collecting information on municipal engineering progress and particularly on city planning.

In all of the European countries which I visited I found great interest being taken in plans for future development of the cities: for better municipal organization, improved public services and transit systems, for new parks, playgrounds and

boulevards (the demolition of old fortifications has made this possible in several instances), and particularly in making comprehensive plans for the orderly growth of the cities. Because of extreme poverty few of the cities are undertaking construction of important works, except for municipal housing to relieve the shortage, which is being done, under various methods of finance, by nearly every important city in central and southern Europe. However, to cite a few examples of projects actually under construction, or proposed for construction soon, Paris is planning to increase its water supply very soon; Brussels has completed a new connecting link between the east and west railway system; Antwerp is about to start work on an enlarged sewerage system; the Emscher district in Germany is continuing (with only a fraction of its former financial resources), to construct sewage treatment works; Berlin's only large public enterprise is the completion of the new municipal subway; Prague proposes very large municipal works, including water works extensions; Milan is at work on a new canal port and other very important works; Marseilles is spending 200,000,000 francs on a huge new port and canal to the Rhine. Partly because of the poverty of the cities the values of the city planning are better appreciated and availed of: to plan for the future in a way to relate the municipal enterprises to each other and each one to a comprehensive scheme for the development of the community, thus to avoid failures, and especially to secure the desired improvements more cheaply and satisfactorily with limited funds than would otherwise be possible. In this way the financial stringency has helped city planning, but the war has also stimulated city planning, especially in the devastated regions, where the re-building is in many instances producing better-planned communities than existed before the war, and with outline plans also for later expansion.

Very truly yours,

JACOB L. CRANE, JR.

Rome, Italy, Oct. 22, 1921.

(Editor's Note:—Mr. Crane expects to return to the United States this month and may be addressed at Robinson Hall, Cambridge, Mass.)

MUNICIPAL ASPHALT PLANTS

The extent to which American cities and other municipalities are now doing their own street repair work with the aid of their own asphalt plants is indicated in reports to The Asphalt Association, New York City, which show that there are in the United States 98 public asphalt plants. Municipal plants are to be found in the following cities: Little Rock, Ark.; Los Angeles, Cal.; Denver, Col.; Wilmington, Del.; Atlanta, Ga.; Boise, Idaho; Chicago, Ill. (3); Indianapolis, Ind.; Bluffton, Ind.; Fort Wayne, Ind.; Topeka, Kan.; Munroe City, Ky.; Shreveport, La.; New Orleans, La. (2); Springfield, Mass.; Fall River, Mass.; New Bedford, Mass.; Northampton, Mass.; Worcester, Mass.; Flint, Mich.; Lansing, Mich.; Detroit, Mich. (3); Highland Park, Mich.; Minneapolis, Minn.; St. Paul, Minn.; Duluth, Minn.; Jackson, Miss.; Kansas City, Mo.; St. Louis, Mo. (2); Omaha, Neb.; Manchester, N. H.; Atlantic City, N. J.; Newark, N. J.; Bayonne, N. J.; Trenton, N. J.; Brooklyn, N. Y.; Syracuse, N. Y.; New York City (4); Niagara Falls, N. Y.; Elmira, N. Y.; Schenectady, N. Y.; Toledo, O.; Cleveland, O.; Columbus, O.; Dayton, O.; Cincinnati, O.; Youngstown, O.; Oklahoma City, Okla.; Portland, Ore.; Harrisburg, Pa.; Johnstown, Pa.; Erie, Pa.; Pittsburgh, Pa. (2); Reading, Pa.; Scranton, Pa.; Philadelphia, Pa.; Providence, R. I.; Pawtucket, R. I.; Nashville, Tenn.; Memphis, Tenn.; Fort Worth, Tex.; Roanoke, Va.; Norfolk, Va.; Portsmouth, Va.; Seattle, Wash.; Milwaukee, Wis.; Superior, Wis.; San Francisco, Cal., and Saginaw, Mich.

The City of Salt Lake City, Utah, has just completed the installation of a modern asphalt plant having a capacity of 750 sq. yds. of 2-in. asphalt pavement per day. Newark, N. J., is reported selling $50,000 worth of bonds for a new city asphalt plant. Quitman, Ga., has also installed a plant.

State highway departments owning their own plants are those of Delaware, Illinois, Maryland, Michigan, North Carolina, Oregon, Pennsylvania, Tennessee, Texas, Utah and Virginia. County highway departments owning plants include: Burlington County, N. J.; Fulton County, Ga.; Fayette County, Ky.; Munroe County, Mich., and Allegheny County, Pa.

In Canada municipal asphalt plants are to be found at Brantford, Ont.; Charlottestown, P. E. I.; Chatham, Ont.; Hamilton, Ont.; Kingston, Ont.; London, Ont.; Montreal, P. Q. (4); Ottawa, Ont.; St. Catherines, Ont.; Sherbrooke, P. Q.; Toronto, Ont.; Victoria, B. C.; Winnipeg, Man., and Windsor, Ont.

The governments of Argentine, Ecuador,

France and Peru, also operate asphalt plants, and one is to be found at Honolulu, H. I.

ORNAMENTAL STREET LIGHTING

By L. A. S. Wood, Manager, Illuminating Section, Westinghouse Electric & Manufacturing Co., George Cutter Works, South Bend, Ind.

The lighting of our streets at night is a vital municipal issue, and adequate illumination, besides being a convenience, is, in addition, a protective necessity to every community. Good lighting is an indication of prosperity and an investment in a well-designed ornamental street lighting system returns large dividends to the taxpayers in advanced real estate values.

Good street lighting creates a psychological impression of thrift and progress, advancing civic pride, attracting favorable publicity and promoting other improvements. It assists the fire and police departments, facilitates congested traffic and decreases crime.

In the early days of electricity, street lighting design was a simple problem, the solution of which generally took the form of a suspended arc lamp at street intersections. With the growth of the "City Beautiful" idea, however, and the demand for lighting systems of a more ornamental character, which will eliminate unsightly overhead equipment, many factors not provided for in the earlier systems have to be considered. The more important of these are the size of the city, the character of the buildings, the presence of foliage on the streets, and the local conditions controlling the distribution of electricity.

Standard of Illumination

The standard of illumination on our streets was set by the earlier types of "open" carbon arc lamps, which were later replaced by an improved type having longer burning hours, known as the "inclosed" carbon arc lamp. This latter was not so efficient as the open arc and its substitution in place of the earlier type tended to decrease the standard of illumination, and it was generally lower than was customary in the larger cities of Europe. It will often be found that the energy consumed in lighting a comparatively small room in a public building is greater than that consumed in lighting one mile of the average city street with ordinary pendant units.

Street lighting rates, with few exceptions, have remained practically constant for many years, in spite of the fact that there has been a large advance in the costs of material and labor. The per capita cost of street lighting is generally low, and there are few cities spending over $3 per capita. The average for the 50 best lighted cities is about $2, and for the whole of the United States not more than 71c per capita.

Requirements of an Ornamental Street Lighting System

Since the introduction of the high efficiency Mazda "C" incandescent lamp, which has revolutionized street lighting, eliminating the ornamental cluster post of earlier days and relegating the arc lamp to the museum, development in ornamental street lighting has favored the single light post equipped with suitable lighting

NIGHT SCENE IN NEW CASTLE, PA., SHOWING THE EFFECT OF IMPROVED WHITE-WAY LIGHTING. NOTE THAT MOST OF THE ILLUMINATION IS DOWNWARD SO THAT THE GREATEST EFFICIENCY IS OBTAINED.

unit or "post top" to distribute and direct the light on the plane of illumination.

The first requirement of an ornamental street lighting system is that, while efficiently illuminating the streets during the hours of darkness, it should be inconspicuous in the daytime, blending harmoniously with the architecture of the surrounding buildings. This is very aptly illustrated by the well-designed ornamental lighting system in the city of Chicago, within two blocks of the busiest part of the Loop.

Another important requirement of good street lighting is that the intensity of illumination should be graduated in accordance with the conditions of the various localities and the flexibility of the Mazda system renders it particularly suitable for this class of work. Until the public became aroused to the necessity of well-designed and uniform systems of ornamental street lighting, progressive merchants installed, at their own expense, systems of ornamental posts or "White Ways," which often resulted in the installation of posts of various designs in different parts of the same city.

This activity on the part of merchants should be carefully directed by the municipal authorities and the uncontrolled installation of "White Ways" should be discouraged. An ornamental street lighting system should be considered as part of a plan to beautify the city as a whole, and not as means of advertising one section, perhaps to the detriment of some other locality.

Promotion and Financing

There are various methods of promoting the installation of ornamental lighting systems, but the most successful have been through the Chambers of Commerce or Commercial Clubs. Municipalities are, as a rule, reluctant to consider such lighting until there is a publicly expressed demand.

In a number of states there are existing laws which permit the establishment of Assessment Districts for the purpose of taxing abutting property for the installation of special lighting. In such cases usually 51 percent of the frontage involved must be signed up to make the petition effective. Street Lighting Improvement Acts have generally assisted the progress of ornamental street lighting, and, where available, should be used. The assessment becomes a taxation and the contract is between the city and the central station, thus insuring a uniform installation with continuity of service, under the control of the municipality.

The assessment of property owners for the upkeep of lighting installations is not new, and the following extract from "Municipal Government," by Frank J. Goodnow, LL. D., published in New York by the Century Company in 1910, page 328, describing Paris in 1666, is of interest:

"The expense of lighting the streets was defrayed also from the receipts of a

A STANDARD LOCATED ON THE SIDEWALK WHICH HARMONIZES WITH THE SURROUNDINGS AT MIAMI BEACH, FLA.

tax imposed on the householders. Mildmay says: 'Two persons are generally contracted with for this undertaking, the one to find the lanthorns, cords and pullies; and the other to supply the candles; for the streets are here illuminated by hanging lanthorns on the middle of a cord that reaches across the street; and is fixed to pullies on each side, at about 15 ft. high and about 15 yds. distance from one another. There are 65 lanthorns and consequently as many candles consumed each time they are lighted, which is only 20 times a month, being laid aside during the moonlight nights and are never lighted, but from the last day of September until the first day of April each year; being taken down and set apart during all the summer months.' Elections were held annually in each quarter of the city by the householders. The persons elected had each charge of 15 lanterns and paid, as Mildmay puts it, 'Some menial servant or poor housekeper in the same street to perform the duty; accordingly every eve-

ning, as soon as it begins to grow dark, the commissary sends out a person, ringing a hand bell through the streets of the quarter to give notice, as in the morning for cleaning the streets; so now for lighting them; upon which each lanternier's servant immediately sallies out and having a key to the iron box in which the end of every cord is fastened on the sides of the streets, lets down the lanthorn hanging on the same and fixing his lighted candle therein draws it up again; and thus everyone having only 15 lanthorns under his care, the whole city is illuminated in a very short space after notice; though the light itself is indeed a very indifferent one.'"

System of Operation

Owing to its flexibility, the Mazda "C" Lamp is peculiarly adapted to ornamental street lighting, and, when operated on a constant current series system, it affords an efficient and economical street lighting unit, easily installed and controlled, giving a range of from 600 lumens* (60 candle power) to 25,000 lumens (2500 candle power). Any size lamp within this range may be operated in series on the same circuit without changes in the regulating equipment at the central station, and, with suitable enclosing glassware, a soft diffused illumination or a brilliant sparkling light without glare may be obtained.

The regulating equipment generally consists of moving coil type constant current regulating transformers and control panels which limit the current in the circuits, safeguarding the lamps against surges and, at the same time, insuring that sufficient current will flow through the lamps at all times to maintain the rated candle power.

In addition to regulating equipment of the station type moving coil, regulating transformers have been designed suitable for mounting on poles at any point in a high tension distribution network, thus permitting an ornamental lighting system to be connected to a high tension line without the necessity of running special lighting circuits back to the sub-station. This improvement in regulating apparatus, which may be operated either from a time switch or remove control device, materially reduces the cost of installing ornamental lighting systems at a distance from the sub-station. Another method of control for Series Mazda Lighting is the Adjuster or Reactance Socket System. This is generally used for small groups of lighting units and is operated from a constant potential transformer with a reactance coil connected in parallel with each socket. When a lamp burns out, the current is forced through the reactance coil, introducing an impedance in the line equivalent to the energy absorbed by the lamp, thus maintaining the circuit current constant.

MODERN RESIDENTIAL AND PARK LIGHTING STANDARDS IN USE IN VINCENNES, INDIANA.

The earlier types of cluster posts were usually operated on multiple systems, but, while there are still some ornamental lighting systems installed in multiple, the series system is the one generally adopted This condition has made the selection of ornamental street lighting equipment a matter for the engineer's serious consideration, owing to the fact that the equipment—unlike the old cluster posts—is operated on a high tension system, requiring fixtures especially designed for this purpose.

The Underground System

Until the introduction of steel armored and lead covered cable, it was customary

*The Series Mazda Lamp is now rated in lumens instead of candle power and the lumen rating is ten times the present candle power rating.

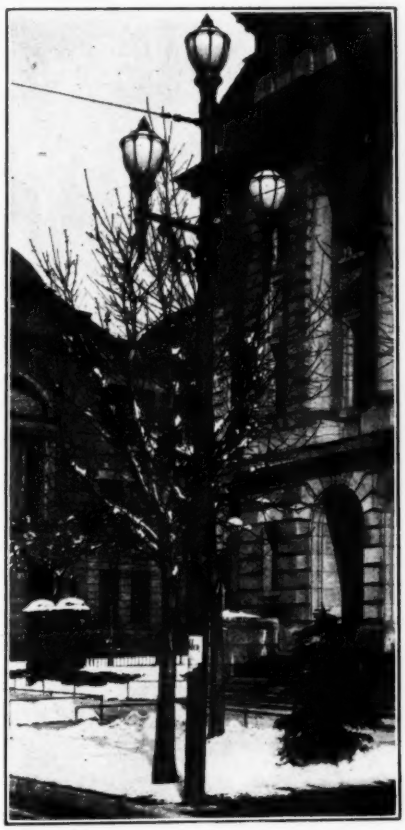
to lay underground cable in conduits, but modern practice favors the use of steel armored cable buried in a shallow trench below the curb or in the Parkway. The steel armored cable consists of a copper conductor (usually of No. 8 gauge) insulated with rubber, over which is a braided cover and jute filling. A layer of tape is then wrapped around and this is enclosed in a continuous lead sheath, covered with a coating of tarred jute. Around this is wrapped two layers of steel tape, so arranged as to insure the steel cover overlapping when the cable is bent. A serving of jute is placed around the cable and affords protection to the steel tape when placed in the ground. If properly installed, the life of this cable is almost indefinite as the lead cover forms an efficient protection from water, while the steel armor protects the cable from mechanical injury. The posts are usually wired with rubber covered and braided cable.

Steel armored lead covered cable should be laid in a shallow trench under the curb or in the "Parkway", if any, and, in this position, it is not likely to be damaged. It is important that ends of the cable, where cut, should not be exposed to the weather. We are all familiar with the precautions taken by Cable Manufacturers to seal the ends of the cable before it leaves the factory, but, unfortunately, very little care is exercised in this direction when the cable is installed. It is quite common, during the installation of ornamental lighting systems, to see the ends of the underground cable projecting through the ground, exposed to all weathers, until the posts are installed and connected, with the result that faults are likely to develop at an early date and the installation becomes a source of trouble and expense.

The best way to install armored cable is to lay it in a prepared trench, leaving a loop at the location of each post sufficiently long to reach the terminal of the disconnecting device in the base of the post and to pour cement around the loop to form the foundation for the post. This is a more satisfactory method than the one usually used of making the post foundations first with the conduit elbows for the cable to be drawn through, as it leaves the cable intact until the time the connections are made in the base of the post.

A disconnecting pothead should be used in the base of the post and this should be of such design as to thoroughly seal the ends of the steel armored cable and efficiently bond and ground the steel armor and lead covers. It should also be designed so that the post wiring is automatically disconnected from the underground system and the circuit in base of post reestablished by a short-circuiting device in the event of the post being accidentally broken.

It is desirable that a device be used in the top of the post for relieving the terminals of the lamp socket from the strain



IN SALT LAKE CITY, UTAH THE LIGHT STANDARD IS USED IN COMBINATION AS A TROLLEY-WIRE SUPPORT.

of the weight of the cable used in wiring the post.

In the constant current series system of operation, the high tension current is carried up the post, and, although when properly installed this is not objectionable, several cities have preferred to use a safety coil in the base of the post so that a voltage equivalent to the voltage of the lamp only is carried up the post.

Safety coils have been designed equipped with disconnecting potheads which have all the advantages of the latter de-

vice, coupled with the safety feature of low voltage in the post.

Part Night Circuits

Occasionally, in the interests of economy, it is found desirable to decrease the illumination on the streets after midnight when only protective lighting is required and this is best accomplished by dividing the lighting system into two circuits, one operating the "all night" lamps and one operating the "part night" lamps. For this purpose, two single conductor cables may be laid in the same trench, connecting with alternate lamps or any other combination desired. If preferred, a twin conductor cable may be used.

Classification of Streets for Ornamental Lighting

In many of the larger cities will be found some exceptionally wide and important streets which will require special treatment; in general, however, for the purpose of determining the correct size of lamp with the best spacing and mounting height, the streets may be divided into three classes, viz.: Important Business Streets, Side Streets and Residence Streets. The following table gives approximate data on this subject, which, however, may be varied to meet local requirements:

Type of Street	Size of Lamps in Lumens	Spacing in Feet	Mounting Height in Feet
Important Business	6000 to 15000	50 to 75	12.5 to 15
Side	2500 to 4000	75 to 100	11.5 to 13.5
Residence	1000 to 2500	150 to 250	10.6

In the important business streets and side streets, the ornamental posts should be set symmetrically opposite each other on either side of the streets, while in residence districts the posts should be staggered.

For exceptionally wide and important streets, a greater intensity of illumination is required, with higher mounting, and, for this purpose, two-light ornamental posts, for use with 15,000 and 25,000 lumen lamps, have been developed.

The Use of Trolley Poles as Lighting Units

On streets where trolley poles are in service, the best method of lighting is by the use of ornamental trolley brackets with suitable lighting units, either with single or double arm, which may be attached to the trolley poles, presenting a very attractive appearance and eliminating the necessity of cluttering up the streets with additional posts.

Another method of adapting trolley poles as ornamental lighting units is to encase the pole in an ornamental cast iron shell with ornamental brackets attached. An attractive unit has been designed with double brackets immediately below the trolley span wire and a single light at the top. The span wire is attached to the trolley pole through a hole provided in the capital of the top lighting unit.

Types of Commercialized Ornamental Posts

Ornamental Posts may be divided into three classes, viz., Cast Iron, Concrete and Pressed Steel.

The earliest ornamental cast iron post, the history of which is preserved, was installed in the Taj Mahal, Delhi, India, upwards of sixteen hundred years ago, and stands today a monument to the durability and lasting qualities of Cast Iron.

Cast Iron Posts will not corrode, neither will they chip or crack under extremes of temperature. They are designed to withstand severe shocks, such as might be received in ordinary street traffic, and present the slender and graceful appearance so desirable in ornamental street lighting units.

Concrete is one of the most durable materials used in construction work, but it has been found that ornamental posts of this type must be of very heavy and substantial construction to withstand extremes of temperature. Unless manufactured with the greatest care, concrete posts will be found to chip and crack in Northern climates.

Pressed Steel Posts generally consist of a shaft of corrugated pressed steel, mounted on cast iron foundation, with an iron capital, the whole bolted together with three tie rods passing through the center of the shaft. This type of post, owing to its construction, presents a massive appearance, but the shaft is readily dented and bent by shocks which would leave cast iron posts unaffected.

The Mazda "C" Lamp

Until about the year 1913, the filaments of all commercial Electric Incandescent Lamps were operated in bulbs from which practically all the air and gases had been removed. The evacuation of the bulb accomplished two purposes, viz.: It prevented the filament being consumed by the oxygen of the air and also prevented the loss of heat by convection. As the temperature of the filament is raised, the

light emitted increases much more rapidly than the energy consumed, but, on the other hand, the rate of evaporation of the filament is increased.

In the Mazda "C" Lamp, the rate of evaporation is reduced by the introduction into the bulb of inert gases, thus permitting the use of a higher operating temperature. Convection losses are reduced by the use of a concentrated type of filament and this renders the use of the Mazda "C" Lamp specially suitable for street lighting purposes.

Constant Current Series Circuits

Alternating current series arc lamps were operated on circuits of either 6.6 or 7.5 amperes and, in consequence, series lighting regulating equipment designed for these ratings became standardized throughout the country. Series Incandescent Lamps were made for use on these circuits in ranges of from 60 c.p. to 1000 c.p., but the larger size lamps did not come into commercial use until the high efficiency Mazda "C" Lamps, operating at 15 and 20 amperes, were introduced. These lamps, owing to the increased size and rugged construction of the filament, have a longer lamp life than the straight series type and are generally adopted for ornamental street lighting systems, except in Residence Districts.

Since the standard rating of series alternating current circuits is either 6.6 or 7.5 amperes, individual auto transformers to step up from the line current to that required by the lamp have been designed, and these are generally mounted in the post top, immediately below the socket. In cases where a safety coil is installed in the base of the post, the auto transformer is omitted and the safety coil serves as the step up transformer. The high efficiency Mazda "C" Lamps are made in the following sizes:

Lumens	Amperes	Average Volts	Watts	Light Center Length in Inches
4000	15	14.9	223.5	9.5
6000	20	15.5	310	9.5
10000	20	25.9	518	9.5
15000	20	37.6	752	9.5
25000	20	60.7	1214	9.5

Note: The nominal candle power of these lamps is one-tenth their lumen rating.

The Light Unit

The problem of street lighting is not like that of lighting a room where the ceiling and walls reflect the undirected light, and provision should be made in the lighting units to direct the light emitted above the horizontal to the plane of illumination. With ornamental post lighting, however, it is desirable that a small amount of light from the upper hemisphere should be directed against the fronts of adjacent buildings, and that glare should be, as far as possible, eliminated.

Glare, within the range of vision of the pedestrian or vehicle driver, should always be avoided. It causes the pupil of the eye to contract in an effort to protect the delicate mechanism of the retina, thus preventing the observer from seeing as well as he would be able to do with a light source of lower intensity, but more perfect diffusion. We are conscious of this phenomenon when entering a moving picture theatre from a street flooded with sunlight—at first no details can be seen, but gradually, when the eye becomes accustomed to the light, or in other words, when the pupil becomes dilated, permitting more light to enter the eye, the interior details become visible.

A STANDARD OF ORNAMENTAL DESIGN ADAPTED FOR COMMERCIAL USES.

The problem of designing lighting units of high intensity, with a minimum of glare, has been solved very satisfactorily by the Reflecto-Lux Post Tops recently introduced.

The Reflecto-Lux Units are the very latest in ornamental post tops and they have been specially designed to distribute a flood of light on the streets, with a small amount upwards to illuminate the fronts of adjacent buildings.

The units have been developed for "Super Whiteway" Lighting, with 10,000

and 25,000 lumen lamps, or they may be used with smaller lamps, if desired.

The light emitted by the Reflecto-Lux Unit is brilliant and sparkling, and the panels, which are of ribbed glass, assist in diffusion and in the elimination of glare.

The distribution is obtained by upper and lower parabolic reflectors which direct the light outwards; in addition, a portion of the light in the upper hemisphere is re-directed by an opal glass band around the upper portion of the lamp, or by a band of enamel on the lamp itself.

In the post top, the lamp burns in a tip up position, and is easily accessible for cleaning, through the top cover which is hinged.

With the variety of ornamental street lighting fixtures now available, the possibilities of efficient and artistic lighting for the "City Beautiful" are unlimited, and public spirited men who are guiding the destinies of American cities will find an easy solution to their problems by consulting the manufacturers of these devices, who have devoted many years of research to the design of suitable apparatus.

The foregoing paper by Mr. Wood was presented before the 1921 annual meeting of the American Society for Municipal Improvements.

LONG INVERTED SEWER SIPHON OPERATES SUCCESSFULLY ON FLAT GRADE

An inverted sewer siphon of interest to engineers because of its length and exceptionally flat grade, was built during 1920 by the United States Engineer Department at Long Beach, Calif. The siphon, as part of an existing sewer, was made necessary by the construction of silt diversion works for the protection of Los Angeles and Long Beach harbors. The 36-in. siphon was installed at the same time as the 27-in. pipe, not only because the United States desired to complete its share of the work pertaining to the diversion project, but also because in heavy rains enough storm water finds its way into the sewer to exceed greatly the carrying capacity of the 27-in. pipe, in which cases it, for brief periods, overtops the wooden partitions and uses the other pipe also. While standard practice would indicate a minimum slope of about 1 per 1000 for a 36-in. sewer, and perhaps 1½ per 1000 for a 27-in. sewer, the 27-in. side of the siphon described is operating successfully with a slope of about 1 in 1200. The main features of the installation are here described as given by Capt. Burt Harmon in The Military Engineer for November-December, 1921.

The silt diversion channel has a bottom width of 530 ft. and a depth of 14 ft., with side slopes of 1 on 1½. It passes through the industrial district of Long Beach and intersects several branches of the former sewer system, including the 48-in. outfall sewer to which all the others were tributary through pumping plants. To avoid unnecessary channel crossings all the smaller sewers are intercepted by a new one paralleling the channel and emptying into a sump, from which the sewage is pumped into the outfall sewer before it crosses the channel.

The problem before the designers was to provide a structure that would (1) maintain a scouring velocity with the present minimum flow in the outfall—approximately ⅛ its total capacity—and (2) be sufficiently elastic to provide for future increase in flow up to the ultimate capacity of the outfall. As the sewer is below flood height, a bridge was considered impracticable. Pumping was obviously undesirable. The only alternative was a siphon.

The siphon as constructed, consists of 2 welded steel pipes 27 and 36 ins. in diameter, laid 7 ft. below the bottom of the channel. The horizontal distance between manholes is 611.4 ft., and the total length of the siphon pipes is 619.1 ft., of which 32 ft. at each end is inclined on a grade of 2 horizontal to 1 vertical. The total fall is 0.50 ft. This very flat grade required that the intake be so constructed as to cause as little obstruction to the flow as possible. For this reason no gates were placed at either end of the siphon, the diversion from the 48-in. pipe to the siphon pipes being made by curved wooden partitions in the manholes.

The invert through the manhole is semicircular, and so designed that when the natural flow in the 48-in. sewer is just equal to the capacity of the 27-in. pipe under the head available, without increase by backwater, the area of the cross-section of the stream is the same at all points between the end of the 48-in. pipe and the beginning of the siphon proper. The same method was followed in designing the 36-in. side. The upper sides of the inclined pipes were prolonged into the manhole so that the floating material will enter them without colliding against a vertical wall. The discharge manhole follows the lines of the intake.

It is estimated that the 27-in. pipe alone will care for the increase in flow for perhaps two years without creating an undue amount of backwater in the approaching sewer. The diversion partitions will then be replaced by others already prepared to confine the flow to the 36-in. pipe, the sewage being by-passed into the channel while the change is being made. When the capacity of the 36-in. pipe shall have been reached, the second partition will be removed and the flow passed through both pipes, the capacity of the two being approximately that of the 48-in. outfall.

The pipe was built in 50-ft. sections with flange couplings. A trench was dredged across the channel, and a trestle with bents 50 ft. apart driven along it. Screws 1½ in. in diameter and 18 ft. in length, with the lower end bent into a hook, were placed through the caps of the trestle over the center line of each pipe. The pipe was assembled suspended by slings from these screws. It was then lowered by turning the nuts on the screws simultaneously, the pipe being filled with water from the city mains as it was submerged. When both pipes were in place, they were covered with earth to a depth of 1 ft., and the trench then filled with broken concrete to the level of the channel bottom. This fill was permitted to settle for about 6 weeks, when the screws were removed and the piles cut off near the top of the concrete fill, the stumps being left for additional security.

The siphon has been in operation for 11 months without either lodgment of floating matter in the manholes or indications of deposit of sediment in the pipe.

DRAINAGE PUMPING PLANTS

By L. C. Craig, Principal Assistant Engineer, Edmund T. Perkins Engineering Co., 38 S. Dearborn St., Chicago, Ill.

Of the many acres of swamp and overflowed lands in the United States a large percentage is so situated that it cannot be entirely reclaimed without pumping. This is especially true of the 20,000,000 or more acres in the Mississippi River Valley.

The drainage of these lands has been largely a development of the last 25 years. During this period many drainage districts have been formed in the Mississippi River Valley, the first areas to be reclaimed being those so situated that all or a part of the drainage water would flow off by gravity. Gradually as the land increased in value pumping plants began to be installed more and more, as a part of the drainage systems. There exist today many areas with no drainage and others where only partial gravity drainage is obtained, where eventually pumping plants will be installed.

Only a few years ago $20 to $30 an acre was considered a big price to pay for the draining of agricultural land. Today, because of increased land value, many areas are being reclaimed at a cost of $60 and more an acre.

Few Reliable Records on Drainage Pumping Plants

Unfortunately, there exist today few reliable records concerning the capacity and efficiency of drainage pumping plants; such records, where found, usually extend back over a period of only a few years.

Many plants have been installed without adequate means being provided for making tests, or those in authority have failed to realize the necessity of such tests. In many cases no engineer is employed after the construction period.

Those matters are gradually being remedied and during the next few years we will see a very marked development of drainage pumping in this country.

Where Pumping Is Required

A drainage area requiring pumping is usually one with the ground level, so low as to require the raising of the drainage waters over a dam or embankment to a higher level. This dam or embankment may be part of a levee system, constructed to protect lands from flood overflow, as is the case in most river bottom areas, or a dam and pumping plant may be placed in an ordinary drainage ditch at a point where, because of a very flat gradient or lack of outlet, it is found impossible to take care of the drainage waters by ordinary ditch construction.

Size of Pumping Plant

The size of pumping plant required for any particular drainage area depends upon a number of varying conditions, among which are:

1. The size and topography of the drainage area.
2. The amount and distribution of rainfall.
3. The system of ditches and drains used, and the amount of storage capacity available in ditches and reservoirs.
4. The nature of the soil and sub-soil as affecting run-off and seepage.
5. The method of operation of the plant and the degree of drainage required.

The first three factors given above are, of course, the most important in the de-

sign of any drainage pumping plant, but all should receive consideration.

For the past 20 years, or more, in Central Illinois and along the Mississippi River pumping plants for removing water from flat drainage areas have been designed for a maximum pumping capacity sufficient to remove in 24 hours ¼ in. in depth of water over the entire area. In Holland and other European countries for a much longer period ¼ in. or a little more has been used as the maximum capacity for drainage pumping plants. Experience in recent years has not shown that the run-off coefficient of ¼ in. should be changed as a standard basis of design under average conditions. But the engineer must be sure to give due consideration to all modifying conditions in each particular case.

All other conditions being equal, the small drainage area of only 1,000 or 2,000 acres will require a slightly larger pumping plant in proportion to its size than an area several times as large. Where some of the area is higher with steep slopes and impervious soil, the run off coefficient for this portion must be made greater; in some cases it will be twice as great.

The amount of rainfall in Central Illinois averages about 35 ins. per year. Of this amount measurements have shown that about 26 to 30 per cent appears as run-off. Rains of 2 to 3 ins. in 24 hours occur occasionally, and rains of 4 ins. in 36 to 48 hours sometimes occur.

In many drainage areas considerable storage exists in lakes and sloughs which it may not be found desirable to drain. This storage capacity, in addition to the storage ordinarily afforded by the drainage ditches, will reduce the size of the required pumping plant. If there exists considerable areas of tiled land, additional storage will be afforded.

Influence of Soil and Sub-Soil

The nature of the soil and sub-soil of the drainage area has a big effect on the run-off, and when the water on the outside of the levees, in the case of a levee district, is at a high stage, on the amount of seepage. If the soil is a close, compact formation, the surface run-off will be heavier from a sudden rain. A sandy subsoil underlying a drainage area is generally an advantage, because the necessity of constructing tile drains and many small lateral drainage ditches may be largely eliminated, but during high water on the outside of the levees the effect may be the opposite, and the amount of pumping increased by an excessive amount of seepage.

Levees exceeding 10 ft. in height are usually constructed with a muck ditch or small ditch excavation 4 to 8 ft. in depth, constructed under the base before the levee is built, so as to bind in and help consolidate the levee fill with the soil formation underlying the base, and levees, when so built, have been found to resist seepage in a marked degree. However, even with a well-built levee and a sand or gravel sub-soil there will be a considerable amount of seepage which rises to the surface of the ground inside the levee or may be intercepted by tile drain or surface ditches. Where such tile drain or surface ditches exist, located parallel to and adjacent to a levee so as to cut off and carry away the seepage, the amount of such seepage waters may be as much as 2 second feet per mile of levee.

A pumping plant should be designed to operate continuously if necessary. Generally, during the winter months little pumping will be necessary, because without growing crops little drainage will be needed, but it will be found to be an advantage to pump occasionally throughout the winter so as to reduce the ground water level and thereby secure an early drying of the soil in the spring. In this manner the run-off from heavy rain coming in the spring will be lessened and the size of the pumping plant which might otherwise be required may be reduced.

Type of Engine and Pump to Use

After the amount of water to be provided for in the capacity of the plant has been decided on, we must next determine the type of engine and pump which should be used.

The importance of a well designed pumping plant cannot be overestimated. Many pumping plants have been installed in drainage districts along the Mississippi and Illinois Rivers which have been operating with very poor economy, because of poor design. In some cases both pumps and engines have been removed and others installed once or more in a period of 10 or 15 years.

A well designed pumping plant does not mean necessarily one having the greatest economy of operation. Usually from 60 to 80 per cent of all pumping is done in the four months, March, April, May and June, and during the late summer and fall months in some localities no pumping at all is needed. It can readily be seen, therefore, that with the plant idle a good share of the time it might not be economical to spend a lot of money on costly

equipment in order to secure economy of operation.

As a usual thing, in a well designed pumping plant using steam, the operating expenses are about half of the total cost, including the fixed charges. Where the operating expenses are much less than half of the total cost it will usually be found that the total cost should be reduced by using less costly equipment. The item of fixed charges, including interest, taxes, insurance and depreciation, should always be given full consideration in arriving at the total costs as in any other well designed plant installation.

Reliability a Chief Factor Governing Design

As pumping plants must be depended upon to operate when needed, and any delay may mean a flooding of large areas with resulting loss of crops, reliability is one of the chief factors governing design. Or, as a usual thing, it may be said that a type of pumping plant which has proved itself reliable and will require the least annual cost, including fixed charges, will be the best.

Several kinds of pumps, including scoop wheels for low lifts, rotary, plunger and centrifugal pumps, are used in drainage pumping, but the centrifugal pump has come to be recognized as best suited to conditions usually found in drainage work.

The number and size of the units to be used will, of course, depend upon the capacity and the conditions of operation. In order to have at least one pump in reserve in case of breakdown it is desirable to have at least 2 units, and one of these units should have about twice the capacity of the other, for the reason that the small unit will operate over longer periods with greater economy. This is especially desirable where steam is used as the source of power, as the frequent starting and stopping and firing up of boilers will necessitate the burning of much additional fuel, and shorten the life of the boilers. Where three or more units are used they should be of equal size. The total capacity of the pumps should be sufficient to pump the maximum quantity of water against a static head about 3 or 4 feet below the maximum expected.

The Friction Head

In order to determine the actual or hydraulic head on the pump, we must add to the static head an amount which should not exceed 3 ft. in a well designed pumping plant. This additional head, called the friction head, is due to the friction in suction and discharge pipes, the velocity head and the losses at the entrance and outlet of these pipes.

In many poorly designed plants not enough attention has been paid to eliminating the losses in the suction and discharge pipes. The entrance to the suction pipe should be expanded so as to reduce the velocity to not more than 3 ft. per second; 2 ft. per second is better.

The centrifugal pump operates efficiently only when running at or near the speed which is suitable for each particular head. Therefore, where the total head is variable, as in most drainage pumping, it is desirable to have some method of regulating the speed. This is accomplished in the case of the steam engine by regulating the speed of the engine and in the case of the constant speed induction motor by belt connecting to the pump and using two or more sets of pulleys so as to secure the desirable speed. This latter method is cumbersome and undesirable and there is the further objection of loss of power with the belt drive.

With a pump properly designed it may be found that the source of power can be direct connected to the pump and any loss in efficiency in the pump due to the operation at constant speed will be offset by the elimination of the power loss with the belt drive. With variable speed drive or with the steam engine or internal combustion engine direct connected, it may be found that there will be losses in the engine itself, due to operation at less or more than rated speed, which will make changes of speed inadvisable. It is necessary, therefore, that the engineer, before designing a pumping plant, should make a thorough study of all data concerning the equipment he proposes to use, and if possible he should examine other plants where reliable tests have been made.

Pump manufacturers will usually furnish characteristic curves showing capacity, brake horse power and guaranteed efficiency at various speeds. Curves should be drawn or computations made showing complete operating conditions, including the total quantity of water and the total number of horse power hours for various heads over a typical operating period of one year. These curves or computations should be compared with the characteristic curves of the pump to see that the pump has sufficient capacity and is so designed as to have a good efficiency while pumping the greatest quantity of water. From these data also the maximum horse power of the prime mover and

amount and distribution of the fuel consumption can readily be determined.

In the case of variable speed drive a proposed operating chart should be made up, showing the proper speed and other operating conditions which should be used to secure greatest economy. The chart, of course, will be modified as found necessary by tests of the plant after construction.

Prime Movers for Drainage Pumping.

Steam engines, electric motors and internal combustion engines are all used as prime movers for drainage pumping. Which should be used, in any locality, depends upon the size of the plant, its method of operation, the cost of fuel delivered, and the availability of competent labor.

In locations where soft coal can be obtained cheaply, steam may be an economical source of power. In large units one of the advantages of the use of steam is that better speed regulation of the pumps can be obtained. A disadvantage, of course, is the intermittent operation of the plant previously mentioned, and difficulty in delivering coal and supplies. In plants of over 200 H.P., it will usually pay to put in high speed automatic condensing engines with water tube boilers. Higher grade engines, such as the so-called "uniflow engine" with superheat, usually are found suitable only for plants of over 300 H.P., where the cost of operation is a much larger portion of the total cost than in a small plant.

Tendency Toward Electric Pumping

The electric drive has many advantages over other sources of power wherever electric current can be supplied at a reasonable rate. The two principal advantages are low first cost and convenience of operation. Usually the cost of an electric drive pumping plant will be about 60 per cent of the cost of a steam plant. Its depreciation is much less than any other form of plant. It can be operated with ordinary labor with few repairs, and in small plants its operation can be made automatic. The tendency during the last few years has been toward electric pumping.

The Internal Combustion Engine

Because of the low cost of fuel oil the internal combustion engine of the Diesel or semi-Diesel type is now receiving a great deal of attention as a source of power for drainage pumping plants. Up to about five or six years ago there were not over 6 concerns in this country building engines of the Diesel or semi-Diesel types. Now there are at least 16 builders of Diesel engines and at least 30 or more firms building various types of semi Diesel or low compression engines.

Many of the types of internal combustion engines now being placed on the market are still in a state of development or have but recently passed that stage; therefore, before selecting this type of engine for a drainage pumping plant, the engineer should make a thorough investigation of the performance of engines which have been in operation at least two years.

Diesel Engines

The full Diesel is an engine using high compression and high temperatures with complicated valve mechanisms, needing an intelligent, skilled operator. Its first cost is also very high, and although very economical in fuel consumption, its use for drainage pumping is practically limited to large plants.

The semi-Diesel or low compression engine offers better possibilities, I believe, for the small plant. This engine will develop a brake horse power hour on about 0.7 pint of fuel oil as compared with about 0.5 pint for the Diesel engine. At present prices, oil of the grade required for these engines can be delivered in most any locality at a cost of from 3 to 4 cts. per gallon. The first cost of these engines at the present time is about $50 to $60 per horse power, about half the cost of the Diesel engine in small units.

There are various grades of oil used in engines of this type, varying from a gravity test of 20 to 44 deg. Baume. The trade name, fuel oil, is applied to all oil residue left after distillation has removed the gasoline, kerosene and light distillates from crude oil and varies in gravity from 20 to 32 deg. Baume. As oil varies in price, the lighter oils costing more, it is very important to be sure that the engine will run successfully on a low grade oil. Some manufacturers will guarantee operation on oil of a gravity of 24 deg. Baume; others will specify a higher grade. In some cases where the low grade oil is specified, there will be a very low content of sulphur or coke required or some other qualification which may raise the cost of the oil.

I recently had occasion to investigate the quality of fuel oil being used by a number of operators of semi-Diesel engines near Chicago, and found that none of them were using the low grade guaranteed by the manufacturers. The cost of the oil being used exceeded the cost

of the low grade oil by from ½ ct. to 2 cts. per gallon.

To be of use in a drainage pumping plant the engine must operate successfully at varying loads, and the regulation of fuel and water supply must be entirely automatic. Some semi-Diesel engines have troubles with their fuel and water regulation under varying loads and this is a matter that requires careful investigation.

With the increasing consumption of gasoline, it is fair to assume that there will always be a good supply of fuel oil and that the cost of this oil will always be low enough so that except in a few localities oil can be used successfully in a well designed engine in competition with coal or electricity. Many central stations are now using Diesel engines and producing electric current at a cost, including all fixed charges, of 2 to 2½ cts. per kilowatt hour.

In conclusion, with reference to the use of the Diesel or semi-Diesel engine for drainage pumping plants, I will say that the development of this form of prime mover for stationary engines has not yet reached a stage where their use can be recommended without very careful investigation of plants now in operation, but I recommend that every engineer, before designing a pumping plant, investigate carefully the possibilities of this type of prime mover.

The foregoing paper was presented at the annual convention of the National Drainage Congress held in St. Paul Sept. 22-24, 1921.

USE OF FINE SEWAGE SCREENS IN NEW YORK CITY

By Kenneth Allen, Sanitary Engineer, New York Bureau of Sewer Plan, Room 1235 Municipal Bldg., New York, N. Y.

The City of New York has five fine-screening plants located as follows: Elmhurst Disposal Plant, Borough of Queens; Thirty-second Avenue Outlet in Flushing, Borough of Queens; Forty-third Street Outlet in Corona, Borough of Queens; Twenty-sixth Ward Disposal Plant, Borough of Brooklyn, and, Dyckman Street Outlet, Borough of Manhattan.

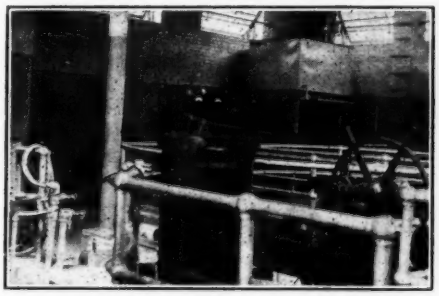
Those in the Borough of Queens are fixed plates, with ⅛x½-in. perforations, cleaned by hand, while those in Brooklyn and Manhattan are mechanically-operated Riensch-Wurl screens. There is also a screen of ¼-in. wire mesh at the Oak Street outlet in Flushing.

The two 14-ft. screens in Brooklyn and their operation were fully described in a paper* read before the American Society for Municipal Improvement two years ago by George T. Hammond, Engineer in Charge of Experiments and Sewer Design, Bureau of Sewers, and a description of the Manhattan plant with a summary of tests made by the late Charles E. Gregory, representing the Borough of Manhattan, and the writer, representing the Board of Estimate and Apportionment of New York City, may be found in the Proceedings of the Society for 1919, as discussions of Mr. Hammond's paper.

Further details of these tests may be of interest.

The Dyckman Street Plant

The Dyckman Street plant was built in 1916-17 at a cost, including grit chamber and submerged outlet, of about $83,700. There are two 14-ft. screens, one having 3/64-in. and the other 1/16-in. slots, housed in a brick building 48 ft. by



INTERIOR VIEW OF DYCKMAN STREET SEWAGE SCREENING PLANT, NEW YORK CITY.

35 ft. in size. Their axes are inclined 20 degrees from the vertical. Each screen has a nominal capacity of about 6 mgd., but the present dry weather flow is but half that amount. One screen—that with 3/64-in. slots—is regularly operated, the other being held in reserve, and excess storm water is by-passed to the river. Each screen, with its brushes, is operated by a 2½ H. P. motor at a rate of ½ r. p. m. and is cleaned by the use of a hose for a few minutes about three times a day and spraying with from a quart to a gallon of petroleum with a watering pot once a day. This is found the best way to remove greasy deposits, which were found to occur to such an extent as to render 1/32-in. slots ineffective. The plant is operated from 8 a. m. till midnight in two shifts, during which period

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* Brooklyn (N. Y.) Sewage Treatment Experiments.

the normal current consumption is 0.7 kw.

There is a drop of a little over a foot from the screen to mean high water level. The screened sewage flows to a well and thence by a 16-in. pipe 160 ft. long to an outlet in 40 ft. of water.

Screenings are dropped from the brushes into a can 24 ins. in diameter by 24 ins. deep to a perforated bottom which permits drainage water to pass off. About 6 cansful are collected daily and after sprinkling with chloride of lime, are disposed of with the City's garbage.

Operation requires two men in the first shift and one in the second. Brushes wear at the rate of about 3/16 in. per year and last between one and two years.

The tests above referred to were carried out in June, 1919. The flow was measured by a weir, the depth being recorded by a Friez float gage checked by direct measurement. The head lost in passing the screens was read on a board gage above the screen as compared with the float gage below the screen.

Tests of Screen No. 1, with 3/64-in. slots, were made:
June 4, Wednesday, 11:30 a. m. to 3:30 p. m.
June 5, Thursday, 10:15 a. m. to 2:15 p. m.
June 9, 10, Monday and Tuesday, 10:15 a. m. to 10:15 a. m.
June 12, Thursday, 8 a. m. to 12 m.

Tests of Screen No. 2, with 1/16-in. slots, were made:
June 16, Monday, 10:45 a. m. to 2:45 p. m.
June 18, 19, Wednesday and Thursday, 10 a. m. to 10 a. m.

Gages were read and samples of screened sewage taken every 15 minutes in all but the 24-hr. tests, when they were taken hourly between 10:15 p. m. and 6 a. m. and every 30 minutes the balance of the time.

Suspended and settleable solids in the raw sewage were determined by adding the amounts shown by analysis in the screened sewage to the amount, in parts per million, computed from the dried screenings and sewage flow. In this way, material errors which have occurred elsewhere in testing screens were avoided.

All tests were made during dry weather except that of June 9, when a sharp shower occurred between 12 and 12:30 p. m. A comparison with the results of other days fails to indicate any marked effect due to this cause.

TABLE I—AVERAGE RESULTS OF TESTS IN 16 4-HOUR PERIODS

Rate of flow	1.74 m. g. d.
Raw Sewage—Suspended solids	143 p. p. m.
—Settleable solids	103 p. p. m.
Removed—Suspended and settleable	27 p. p. m.
Screenings—Moisture	80.2%
—Ash, dry basis	11.2%
—Volume per m. g.	20.4 cu. ft.
—Weight per m. g.	1128 lb.
—Weight per cu. ft.	55.9 lb.
Removal—Suspended solids	19.7%
—Settleable solids	24.2%

The loss of head was very small owing to the small flow as compared to the screen capacity, the greatest average for any test being 0.39 ft. on June 12. The difference between the two screens is brought out in Table II.

TABLE II—LOSS OF HEAD AND REMOVAL IN EACH SCREEN
Average of all 4-m. tests

Screen	No. 1	No. 2
Slots	3/64 in.	1/16 in.
Flow	1.84 m.g.d.	1.63 m.g.d.
Head lost	.20 ft.	.04ft.
Removal—Susp. Solids	23%	16%
—Set. solids	31%	19%

This indicates that the screen with 1/16-in. slots will remove 7/10 as much material under these conditions as the screen with 3/64-in. slots.

The night sewage was found to be abnormally weak and, probably owing to lack of colloidal matter, the percentage of removal was very high. Table III was therefore prepared, showing the weighted results with each screen separately when operating with day and night sewage. (Condensed from Table I of the writer's discussion of Mr. Hammond's paper.)

From Table III the following conclusions are drawn:

1. With day sewage the 1/16-in. screen removes about 1,000 lbs. screenings and the 3/64-in. screen about 1,300 lbs. screenings per m. g. With night sewage each screen removes about 400 lbs. screenings per m. g.
2. The efficiency of removal of suspended solids from day sewage by the 1/16-in. screen is about 14% and by the 3/64-in. screen, 20%.
3. The removal of settleable solids from day sewage by the 1/16-in. screen is about 23% and by the 3/64-in. screen, 27%.

With night sewage each screen removed about 400 lbs. of screenings per m. g., but the results were so erratic that it was not possible to draw conclusions as to the analytical results and efficiency. The removal of suspended solids, for instance, varied from 14.3% between 10 p. m. and 6 a. m., June 19 and 20 with 1/16-in. screen, to 92.5% between the same hours June 10 and 11 with the 3/64-in. screen. This last extraordinary figure is probably due to the fact that the small amount of material removed consisted of sticks, rags, paper, etc., floating in water containing little finely-divided organic wastes.

So far as can be told by the above tests a removal of 20% suspended solids may be considered a fair general figure to assume provisionally in estimating the effect of fine-screening by 3/64-in. Riensch-

Wurl screens with fresh sewage of this character, while nearly 30% of the settleable solids should be removed, these, by the way, being those that are the more objectionable to sight and responsible for the larger part of sludge deposits.

TABLE III—TESTS OF RIENSCH-WURL SCREENS AT DYCKMAN STREET PLANT, MANHATTAN, JUNE, 1919

Average results, weighted in proportion to flow during the individual periods of observation.

Screen	No. 1		No. 2	
Diameter	14 ft.		14 ft.	
Width of slots	3/64 in.		1/16 in.	
Day or night sewage.	Day	Nt.	Day	Nt.
Crude Sewage—				
Susp. solids p.p.m.	175	48	151	55
Set. solids p.p.m.	133	48	93	55
Screened Sewage—				
Susp. solids p.p.m.	139	21	129	46
Set. solids p.p.m.	97	21	71	46
Screenings—				
Susp. sol. rem. p.p.m.	36	27	22	9
Moisture %	78	78	82	83
Dry material %	22	22	18	17
Vola. (dry basis) %	88	84	91	91
Ash (dry basis) %	12	16	9	9
Vol. cu. ft./m. g.	27.1	9.5	18.4	9.2
Weight lbs./m. g.	1449	447	1040	447
Weight lbs./cu. ft.	53.4	47.0	56.5	48.6
Efficiency of Removal—				
Susp. solids %	20.6	56.2	14.6	16.4
Set. solids %	27.1	56.2	23.7	16.4

In May, 1920, samples of the Dyckman Street screenings were analyzed with the following results:

TABLE IV—ANALYSIS OF SCREENINGS

Weight per cu. ft.	58 lbs.
Moisture	68.2%
Total nitrogen, dry basis	2.25%
Loss on ignition, dry basis	73.8%
Ash, dry basis	26.2%
Fats (ether soluble), dry basis	21.1%
Phosphoric acid, dry basis	1.11%
Potash, dry basis	0.064%

The analytical work in both the Brooklyn and Manhattan tests was performed by W. T. Carpenter, Chemist.

The foregoing paper by Mr. Allen was presented at the 1921 convention of the American Society for Municipal Improvements.

ADVANTAGE OF A TOPOGRAPHIC MAP IN CITY PLANNING AND ZONING

By Jefferson C. Grinnalds, Asst. Engineer, City Plan Committee, City Hall, Baltimore, Md.

It is a settled fact that a map of a city on which to study and lay out a plan for any proposed extension of the street system is necessary. It is a requisite too for replanning old parts of the city systematically to study traffic conditions, to show offsets that break the continuity of streets, to show bad angles, block distances, dead end streets, inadequate widths and inefficient functioning of existing thoroughfares. A map of some kind on which to lay out a major street plan is absolutely necessary; and since zoning is an essential part of city planning, its requirements must be supplied and maps are indispensable for a zone plan, indeed they are a part of it. There are many other reasons why a map of a city is necessary in planning.

Planning Without Sufficient Information

If it may be accepted as a condition precedent to studies for drawing a city plan, that some kind of diagram of the present layout is necessary, then the kind of maps must be determined. Suppose those at hand are similar to the common well known automobile maps, which show merely street alignment depicted to a scale of approximately 2000 ft. to 1 in. or 1000 ft. to 1 in. Of what service would a map of this kind be? If it were noticed that there were in some places 2 parallel streets which ran thus for, say, 1000 or more feet without a connecting cross street ,the city planner might say "Why not open between these two parallel streets, a cross-town street which is dead-ended on opposite sides of this long unbroken block?" He can see from inspection of the diagram what seems to be a desirable opening. It is not apparent from such meagre information that the grade on the proposed connection would be as heavy as 10 per cent. Why? Because there were no elevations given nor were there contours showing approximately the probable grade.

Imagine another problem that must be solved. Several parallel streets are shown on this diagrammatic map, crossing a railroad yard which lies contiguous to a railroad main line. There is no indication to guide the engineer in his diagnosis of the kinds of crossings over the tracks. Are they at grade, are they elevated above the tracks, or are they depressed below the tracks? If such crossings as exist are dangerous, what is the remedy? He cannot tell positively with no more facts to help the solution. If he had a contour map which showed the relative locations to scale, he would know at once the conditions on the ground and where to look to find the railroad in a cut or on a fill where the streets could cross overhead or underneath respectively. In one or both places he would advocate a bridge. Innumerable cases can be cited where it is absolutely necessary to have a topographic map, showing contours and surface detail for study on which to base a comprehensive city plan.

Kind of Map Necessary

From the foregoing, it seems that a map is necessary and further that it should be a topographic map. Assuming that to be a correct conclusion, the next step is to determine what the map should show. The first consideration is the existing street layout. All streets that are built up or marked on the ground should be recorded by the field survey parties and plotted on the map. Old lanes and drives should be included. The office force should be employed at the same time, compiling all the data accessible for platted parcels of land. Many such subdivisions have been laid out on paper with no streets having been staked off on the ground. All plats on record or of which any information can be obtained should be located on the field sheets when they come in. Improvements such as buildings of all kinds ought to be located on the field maps including railroads, street railway lines, streams, shore line, lakes, reservoirs, retaining walls, dams, bridges, quarries and wooded areas. Fences and their character, such as wire, pailing, rail and old fence lines, hedges and rows of trees that might indicate old property lines, are requisite to a good map. The state of cultivation is desirable, differentiating by suitable standard signs, orchards, meadows, plowed land, corn fields, pine woods, etc. Lastly, contours must be located and plotted.

Scales

Having decided what physical features are to be shown on the topographic map, it is necessary to determine the scale and contour interval. The former ought to be one which is readily plotted in the field on a field drawing table. When it is remembered that rows of brick houses are to be shown, it is not practical to draw them at a scale less than about 200 ft. to 1 in. To be able to scale within a foot or two, the width of a street or sidewalk, the above mentioned scale is almost the minimum. The well known map of Baltimore, made by the Topographical Survey Commission of that city in 1894, is a masterpiece of that kind of work. It is drawn to a scale of 200 ft. to 1 in., with a contour interval of 5 ft. It was found to be admirably suited as a base for working out a plan for streets in the hitherto unplanned territory within the city. The contour interval of 5 ft. seems to be right for street design and determination of grades. It may be that over very flat terrain a lesser interval may be necessary for sewer design and to a less degree for water main locations.

Degree of Accuracy

Here it is well to decide how good the map must be from the point of view of accuracy. It should be based on a primary triangulation system, the stations of which may be regarded as nearly permanent and accurate to within 10 seconds for closure of any quadrilateral. The secondary and tertiary stations should be almost as good as the primary. There ought to be one or two accurately measured base lines, corrected for curvature. On the triangulation there should be run out all the main roads and cross-country, a traverse control with a maximum error of 1 in 10 or 15,000. The reason for these standards of accuracy is that after such a map is complete, there is left on the ground a control from which detailed property surveys can be made, street intersections computed and established coordinately in the down-town districts where assessed land values are high. Traverse points should be iron rods or pipes placed in the most protected places along highways or in open country, or copper bolts set in curbs or on sidewalks, all well referenced for future use. A net of precise levels ought to be spread over the area to be mapped, bench marks placed on the most permanent structures at about half-mile intervals. Wye levels can be run to traverse points and temporary stadia stations. Maximum error for precise levels should not be over about 3-16 of an inch to the mile.

Costly Errors Obviated

Why all this elaborate, detailed description of a map and what is the excuse for making it? Cities used to be laid out without one, it is true. What kind of a layout was it? Well, when a street was designed to be a straight street, it was so drawn on paper, so built on the ground and regardless of hills or ravines, it kept on. The costs leaped up for cuts and fills and bridges. If the way led to a railroad, it passed over at grade more than likely, leaving a heritage of danger for several generations, ultimately saddling the taxpayers with the burden of expenditures to eliminate at considerable cost, the death trap. Had a map been available, showing by contours the existing hills, valleys, streams, railroads, etc., it is probable that the entire street plan would have been different. When a large city of today was in the village or town stage, its whole scheme of streets would have been designed to fit the topography, had proper maps been made. The present small town should benefit by the costly lessons that the large ones have learned

too late greatly to alter the down-town sections without prohibitive cost.

Steps In Planning

Take the initial stage—suppose a new city is to be built on a proposed site. The topographic map is made. It is possible to determine at once certain rocky, precipitous cliffs, bluffs, wooded ravines, steep hillsides and other suitable areas for future parks. These may be eliminated from the flat or gently rolling terrain so well adapted to building and over which a street plan must be studied. The old country roads, shown on the map, are the existing highways of travel. Some may fit in with a general scheme and others will not. A study will reveal the natural location of the points of ingress and egress for railroads. They will not come into town over the hills. They will enter by certain low grade lines and along them will be suitable territory for industrial development. On the higher ground will be the housing area. It is necessary to determine where the central business area should be. These various districts must now be connected. Radials from the center of town to the outlying sections must be provided. Cross-town and circumferentials must be provided. These streets are the basis for a major street plan. They need not be absolutely straight. The alignment may be determined by the contour of the ground, thereby giving easy grades but with the most direct route consistent with reasonable grades.

New Territory to Be Laid Out and Old City Replanned

An old city that requires a plan for undeveloped or recently annexed territory and that needs replanning in built-up portions, requires a topographic map. In almost every city of that type the street plan was drawn on a flat diagrammatic map. With the general information shown on a complete topographic survey, it is well to work out proposed extensions of the park system, reaching out into the undeveloped country, embracing the ravines, etc., and certain other land suitable for parks. These may then be connected by proposed parkways. These areas being determined, it is unnecessary to lay them off into streets. The city plan is simplified to that extent. The major street plan may be laid down on broad lines. Existing grades may be corrected. Slight alterations may serve to give good results. Certain sharp curves may be eased up by curves of longer radii and offsets may be cured by cutting off some corners. The buildings being shown, studies of the cost of widening may be made and where it is necessary to accommodate the present or future traffic, a new building line may be determined and fixed. The map gives a good idea of the kind of improvements situated within the new lines. In the old parts of town the elevations may show a major street to be necessary on a high grade and not far distant a low grade artery may be indispensable. Prosivion can be made for connections between the two. In outlying territory, similar conditions may prevail. In the absence of a contour map, this could not be seen without a close inspection of the ground and even then the exact locations could not be made unless a survey were available.

Efficiency and Economy

The old checker-board street systems are not practicable, efficient or economic over rolling country. Once upon a time that was the only practice. Closer study with broader information at hand and more intensive efforts at scientific planning have tended to make a street plan more nearly fit the natural ground. Some cuts and fills can not be avoided but they can be reduced in number and in magnitude, by a more rational layout which is not only less costly by being more readily adaptable to the surface, but after all it is more beautiful. The monotony of the long uninteresting city streets so common in all cities will give way to the gently curving and sometimes winding parklike road. A contour map is the best possible guide for the city planner. It is likewise a guide to those who would develop land for sale as lots. They can see from such a map how best to make a street layout involving the least expenditure for grading and which will give the best street connections. New streets can be made coterminous with those already existing or a good reason for not doing so will usually appear on the map showing contiguous property. Much money can be saved to the city and to the land owners by the use of a good survey and its cost will be returned many times. Indeed grading cost alone on 1 or 2 of the existing main highways of some of the large cities has cost more than a topographic map would cost and had it been available, the alignment might have been different, avoiding part of the outlay for grading.

Grade Crossings Avoided

Outside of what we might call the congested part of town and farther toward the outskirts, major streets may be laid out almost a half mile apart and crossings of railroads and deep gullies may be situated at about half mile intervals.

These railroad crossings can be readily determined by studies of the topography. It may be found that where the road is in a cut or fill, there is the logical place to cross instead of at grade any old place as they used to do. The writer emphasizes the grade crossing menace and its abolishment by proper study, because it is so prevalent in all towns.

Sewer Design Depends On Topography

No other feature of city building depends more on the topography than the sewers. The $20,000,000 expended on a comprehensive sewerage system for Baltimore was based entirely on the map of 1894. On it the natural drainage could be traced and the storm water sewers followed it. The drainage area could be readily computed and the size of mains determined. Sanitary sewers were designed too from study of the surface as surveyed and by reasonable deductions as to the use to be made of certain kinds of land. Grades too were an important factor. Water mains are more easily located by having a map showing all physical features so the pipes may conform to the hydraulic gradient and the areas they are to serve will have their bearing on the size.

Rapid Transit

For thorough study of a proposed rapid transit system, a topographic map is essential. Elevations of streets, railroads and streams will give a clear conception of what levels the underground system will have to meet. If an elevated structure is necessary the same data is available and where the way may be in open cut on the surface, or on fill, safe and properly located crossings will be situated at suitable intervals.

Correct Base Map for Zoning

Since zoning is a part of city planning, inquiry as to the kind of a map on which to base zoning studies is apropos. It seems necessary to have a correct and complete representation of all present conditions. The buildings must be shown in order to draw clearly in detail an existing use map of the city to be zoned. A good base map would show on inspection that the buildings are of frame, brick, stone or steel construction. It will appear that some of the buildings are attached, that is, built in rows without side yards. Others will appear to be of the type known as semi-detached houses built in pairs, joined on one side with one side yard to each unit of the couple. Detached houses with two side yards to each house will be noted. Such a map as has been recommended above will show the buildings which sit back from the front lot line and those that are built up to the street line. The fundamental maps on which zoning studies are based can readily be prepared. It will be easy to give each house a color to denote its use, such as 1-family residence, 2-family residence, 3 or more family residence, business, industrial, and nuisance uses. Other sets of fundamental maps can be prepared easily, showing by color the heights of buildings, per cent of area of lot covered by buildings and the assessed land values on a front foot basis.

Necessary Guides in Selecting Zones

Certain other studies preliminary and essential before drawing a tentative zone plan, can be made from the topographic map. The built-up areas are noticeable at a glance. The trend of growth out the main highways and the development between them is apparent. Parks and cemeteries, where people do not dwell and therefore, where zoning for residence or business will not be necessary, show on the map. It will show by the contours and physical features, the lands suitable for future parking; along the streams, ravines, cliffs, etc., where the land is not so adaptable to building purposes. Low flat lands along the waterfront and railroads, suitable for industrial sites, for railroad yards, warehouses, piers, docks and shipyards are ready determined. The topography directs attention to the areas suitable for residential development. They can be so designated on the proposed use district maps. Housing areas convenient to industrial districts, to insure ample and satisfied labor supply are necessary. They are chosen with great care and discrimination, with due consideration for the existing developments. The engineer can with understanding, with knowledge of the growth of the city, with information shown by contours, select major traffic streets which will probably become retail business streets or heavy commercial haulage ways. Parkways and boulevards for the highest class residential frontage may be well chosen. All of these aspects of a zone plan are at once before the engineer or city planner who has an accurate, comprehensive topographic map upon which to work.

Maps of Baltimore Ideal

In 1894, the Topographical Survey Commission of Baltimore began the preparation of a topographic map of that city on a scale of 200 ft. to the inch, with contours at 5 ft. intervals. The map covered 30 square miles, the city's area at that time. The old part of the city prior to the annex of 1888 had been planned in

1819 without reference to topography. On the new map a plan was drawn and adopted for the development of the territory annexed in 1888. The city is now following that plan. In 1914 another map showing all the buildings in the city was made with the surveyed street plan as the frame work. In 1918 an additional 60 square miles of territory were annexed. Now the topographic map of 1894 is being extended to embrace the new addition and should be complete by 1922. These maps will give ample information on which to extend the street plan, design sewer extensions and water mains and to draw a zone plan, which ought to be the very best obtainable since it will be based on a mass of data not usually available for zoning studies.

Cost and Compensations

Does the cost of making such a map pay? Well, if Baltimore's sewerage system cost $20,000,000, it is conservative to estimate that 1 per cent of that amount or $200,000 would have been spent for surveys had not the map of 1894 been made. The map was paid for then by saving on one project. Thousands of dollars have been saved to property owners and taxpayers by reason of having a map available for the use of surveyors and engineers. By planning streets with reference to the contour of the ground the expenditure has been paid for many times over. City planning pays and the use of the term "city planning" ought to include the topographic map as the first step toward a comprehensive plan.

The foregoing paper by Mr. Grinnalds was presented before the 1921 annual convention of the American Society for Municipal Improvements.

SLUDGE HANDLING AT THE ROCHESTER, N. Y., SEWAGE DISPOSAL PLANT

By N. Adelbert Brown, Engineer in Charge of Sewage Disposal, City Hall, Rochester, N. Y.

The sludge beds at the Rochester (N. Y.) sewage disposal plants were designed on the generally accepted rule of 1 sq. ft. to 3 persons, and under the local climatic conditions this area has proven satisfactory. The Irondequoit Plant handles combined sewage. The 10 Imhoff tanks are preceded by grit chambers and Reinsch-Wurl screens and are designed to serve 200,000 persons. There are 40 individual beds, each approximately 44 ft. square. The tanks are built in double units with a common sludge trough. This trough is on the wall between two rows of four beds, allowing the sludge from any tank to be diverted to one of eight beds. The troughs have a slope of 1 in 50 which gives a high velocity and are nearly self cleansing. The sludge is discharged onto the center of the bed through an 18-in. opening controlled by stop boards in the side of the trough. The sludge falls onto a concrete splash plate. A depressed channel extends transversely to the sludge troughs between the first and second and the third and fourth beds of each tier. This channel is 4 ft. below the top of the bed and 9 ft. deep and 9 ft. wide. In this channel is laid a narrow gauge track for the sludge cars and on the walls are tracks for a Gantry crane.

The beds are level and consist of 2 ins. of fine sand, 3 ins. of coarse sand, 8 ins. of gravel and 6 ins. of broken stone. They are under-drained by 3-in. farm tile laid with open joints on 8-ft. centers. These tile discharge into an open drain under the track channels.

The Imhoff tanks have two rings of perforated pipe in each hopper and the sludge is agitated each week. The sludge pipes are also blown out and left filled with clear water after each drawing. No cones are found in the sludge surface and no plugging of the pipes has been experienced.

Drawings

Drawings are made during the season as often as the removal of the dried sludge permits. Nine inches of wet sludge are drawn on a bed. The drawing season is reasonably constant as shown by the following table:

Year	First Drawing	Last Drawing	Period In Days
1918	April 15	Nov. 15	214
1919	April 29	Dec. 10	225
1920	May 7	Dec. 21	228
1921	March 24		

While the season is nearly the same each year the number of drawings varies according to the weather. In 1920 each bed received nine fillings, an average of one every 25 days. In 1921, an extreme drought permitted 7 drawings between March 24 and June 23, an average of one every 13 days with the longest drying period 22 days and the shortest 10 days. Up to Aug. 10, 1921, four additional drawings have been made which gives a season's average to date of 12.6 days per bed.

Sludge Handling Equipment

To remove the dried sludge, two trains of six 1½-yd. Koppel cars are used. The

trains are run in the depressed channel under the Gantry crane which lifts the car bodies from the trucks and sets them on the bed and replaces filled bodies on the trucks. In loading cars stone forks are used and the sludge lifted in cakes approximately 12 ins. square. A few extra car bodies set on the beds permit the moving of trains without delaying the labor force. The trains are hauled by storage battery locomotives and the crane is electrically operated as power is developed at this plant from the effluent.

Organization

The usual force consists of one foreman, one hoist man, two locomotive runners and eleven laborers. Eight men do the loading, one is on each train to dump the cars and one is at the dump to keep the track clear. This crew will remove on an average 200 cu. yds. of loose dry sludge in 8 hours. With labor at 50 and 55c. and neglecting power costs, this sludge is delivered to the spoil bank at 33c per cubic yard.

During much of the season, the sludge is sold to farmers as removed from the beds. The cars are run to the tipple and dumped directly into the wagons or trucks. As the tipple is located farther from the beds, the additional haul and delays in dumping increase the cost of removal 10 percent.

Moisture Content

The sludge, when drawn, contains from 79 to 86 percent of moisture. It is more dense in the first drawing each season and is thinner as the season progresses. At the time of removal the moisture is reduced to from 50 to 60 percent. A rain on the beds after the cracking has occurred packs the sludge so that it is difficult to reduce the moisture below 60 percent in any reasonable time. The shrinkage in drying is normally a little more than half of the wet volume. Analysis of a dry sample yields 2.2 percent nitrogen and 56.3 percent mineral matter.

Due to the depth of the tanks, the entrained air bubbles expand greatly when drawn onto the bed and make the dried sludge a light, porous cake.

Quantity of Sludge and Use as Fertilizer

The quantity of sludge varies, but the average for three years has been 1.51 cu. yds. of wet sludge per million gallons. In a large plant the disposition of the dry sludge becomes a problem. Realizing this, the plant at Rochester started in 1918 to develop a demand for it as a fertilizer. During that time it was given to any farmer who would load and draw it away. The plant is located in a fruit and truck garden section having a sandy loam soil. Reports of the use of this fertilizer were not enthusiastic. This was in part due to a belief that enthusiastic reports would increase the price. In 1919 a charge of 50c a load was made, the buyer loading from the dump, and more was drawn away than in the previous year with no charge. A proposal came from the farmers that with a more convenient method of loading they would pay a higher price. The tipple was erected and the price put at 75c per car, the car holding nearly 2 cu. yds. When sludge is not being removed, the dump is still open at 50c per yard. During 1920 the income from this source was $1,015. To July 1, 1921, it has been $650. The income is small but the disposal of continually increasing quantities is preventing an accumulation on the grounds of the plant.

It is being hauled for distances up to five miles. In peach, cherry and pear orchards it is used as a top dressing spread around the trees. On the truck farms it is spread with 50 yds. to the acre and ploughed under. The truck men use it under corn, tomatoes, celery, cabbages and melons. It is still impossible to obtain reports favorable to sludge, but the same farmers are drawing it after four years of trial and using more than ever before.

The foregoing paper by Mr. Brown was presented at the recent annual meeting of the American Society for Municipal Improvements.

MANDAN, NORTH DAKOTA, DISCARDS OLD AND INSTALLS NEW STREET LIGHTING SYSTEM

Even in these days when so many cities and towns are realizing the necessity of better street illumination and are installing new and improved types of lamps and standards in large numbers, the discarding of its entire street lighting system by a municipality and replacing it with a new one is sufficiently interesting to make it worthy of remark.

The city of Mandan, North Dakota, which has a population of about 4,600, has done so; and in so doing it has attained the distinction of having, probably, more ornamental light standards than any other place of anything like the same number of inhabitants. It has 447 in use, or approximately 1 to every 10 inhabitants.

The New Units

For a number of years its streets were lighted by 50 arc lamps. These have been removed and replaced by a system that is coming into very general favor—Mazda lamps enclosed in ornamental globes supported by ornamental iron posts. The change has been made at a cost of less than $100,000, while the gain in the appearance of the city and in the efficiency of its street lighting has been extremely noticeable and gratifying.

The lighting units, which are of the Novalux type, were made by the General Electric Company, Schnectady, N. Y. In the business district the Form 9 unit, with diffusing globe, glass canopy, and series film socket is used; in the residential sections, Form 8 is employed, the equipment being similar to that used in the business district. Ten and one-half foot ornamental iron standards and 100-candlepower lamps are used in the residential sections, and 12-foot standards and 250-candlepower lamps in the business district. It was originally intended to use a 400-candlepower lamp in the latter, but it was decided to employ those of 250-candlepower, which proved to be ample. The standards, which were made by the King Manufacturing Company, are uniform in design in both the residential districts and the business section, and are of graceful and pleasing pattern. The system is arranged and operated in four circuits, that of the business district being separate from those of the residential sections, and in each case the corner lights are on a different circuit than the intermediate lights.

The installation was designed by Black and Griffin, consulting engineers, of Mandan, and the contract was let, under competitive bids on plans and specifications prepared by them, to M. S. Hyland of Fargo, N. D. The type of standards used was selected by the City Commission.

Amount of Breakage

The breakage of lamps, globes and canopies has been very small, it having been as follows from December 20 to June 16:

Month	Lamps	Globes	Canopies
December	12	1	1
January	22	1	1
February	32	6	6
March	16	1	1
April	13	2	2
May	31	2	2
June	13	1	1
TOTAL	139	14	14

Features of Installation

Mandan has about 9½ miles of street lighting and approximately 3½ miles of paved streets. A number of standards were, of course, installed along unpaved streets. In these cases the posts were placed on the curb line at what will be the grade and street line when the street is paved, and 6-ft. sections of curb were set in for protection. All the cable was laid 12-ins. below the paving grade on unpaved streets, just under the edge of the sidewalk where the sidewalk extended to the curb, and across streets at right angles to the center of the street in 2-in. iron conduit pipes. All pipes crossing paved streets were pushed across, and no pavement was cut. It is interesting to note that in making the installation, approximately two carloads of cement, 1,200 cu. yds. of concrete and 140,000 ft. of No. 8 single conductor cable were used.

Operating the System

All the lamps are operated until 9:30 p. m. The corner lights are then turned out and only the intermediate lamps are burned until morning except on Saturday nights and special occasions, when the entire system is operated. The cost of maintenance and operation is paid out of the general fund for street lighting made by the usual levy. Power for operating the system is supplied by the Mandan Electric Company, a privately owned corporation, but the city installed and owns the switchboard panels, meters, etc. The lights are controlled by employes of the company under the direction of the City Commission. The rate paid is 5 cts. per kw. hr.

Consumption of Current for Six Months

The lighting schedule and the consumption of current for the first half of the year were as follows:

January	5:00 p.m. to 7:00 a.m.	11,750 Kw. hr.
February	5:30 p.m. to 6:20 a.m.	10,080 Kw. hr.
March	6:00 p.m. to 5:00 a.m.	8,540 Kw. hr.
April	6:30 p.m. to 4:00 a.m.	7,470 Kw. hr.
May	7:00 p.m. to 3:00 a.m.	5,500 Kw. hr.
June	8:00 p.m. to 2:40 a.m.	5,400 Kw. hr.

Costs

The job was divided into three contracts, other districts petitioning for the improvement after the first contract was under way. The total of the three was $95,721.84, including engineering, assessing and advertising as required by the laws of the state. The cost of the installation was met by special assessment against the property directly benefited. It was decided by the special assessment commission that all lots were equally benefited whether or not there was a light directly in front of the lot or opposite, provided they were equally spaced on the street around the entire block. The cost per lot was higher on

the last two contracts let, and the average of a 50 x 140 ft. lot in the residential section on the main contract was $90.16, and on a 25 x 140 ft. business lot, $48.63, these costs being based on cash payment. The assessment was spread over a period of 5 years and warrants were issued bearing interest at a rate of 6 per cent. In the residential section the assessment commission held that a corner lot received no more benefit than an inside lot, even though there might be lots on the side; but in the business district the corner lots stood the cost of the light on both sides.

SATISFACTORY TRAFFIC STANDARDS AT LA GRANDE, OREGON

To the Editor:

I send herewith a photograph of a traffic standard which has proved to be very satisfactory since its installation here some two months ago. Thinking perhaps that it might be used in other cities with the same results I am taking this opportunity to describe it to you.

The base is of reinforced concrete 2 ft. in diameter and 1 ft. in height of which 5 ins. is vertical. The disks are 9 ins. in diameter and are cut half in two and placed at right angles in a piece of 1¼-in. pipe, 30 ins. long, 6 ins. of which is embedded in the base. The disks are placed in slots sawed in the pipe which cuts the pipe into 4 pieces, these pieces are bolted together in pairs. We made 11 of these standards at an approximate cost of $9.56.

HOME MADE TRAFFIC STANDARD USED WITH SUCCESS AT LA GRANDE, OREGON.

Several machines have collided with these traffic signs but have done very little damage to the standards and the same machine has not hit the standard the second time.

Trusting that this information will prove of benefit to other cities, I remain

Very truly yours,

GEORGE GARRETT,
City Manager.

LaGrande, Ore., Dec. 1, 1921.

IS THERE AN AMERICAN PRECEDENT FOR REDISTRIBUTION OF RECLAIMED LANDS?

To the Editor:

It sometimes occurs in the progress of flood control undertakings that we should like to provide for the reclamation and *redistribution* of low lying lands.

In various countries of Europe there are laws which allow municipalities to re-subdivide areas which are badly adapted to their purposes, and to redistribute these areas among the former owners, giving each owner an area of equivalent value, or, if there is any failure in the equivalence, to pay him damage or charge him benefits, as the case may be, but not necessarily to return to him the identical area which was surrendered. The best known statute of this sort is the Adickes Law, or Lex Adickes, of Prussia, passed at the instance of Dr. Franz Adickes of Frankfort.

So far as we can learn, no similar legal provision ever has been made effective in this country. In 1806 the United States Congress made such provision for the City of Detroit after the city had been burned. The replatting and redistribution of property took place, but I think the matter never was determined in court.

If any of your readers know of any American precedents for this course, we should be pleased to learn of them.

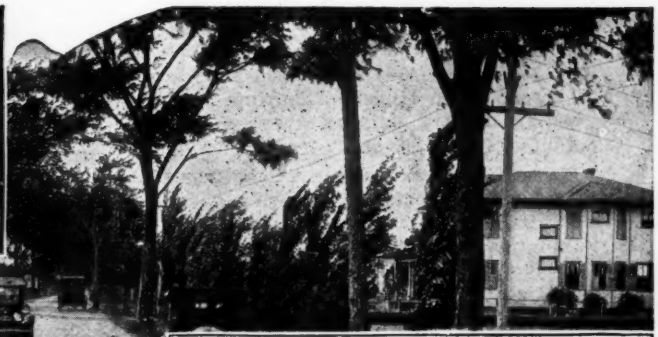
Very truly yours,

DAYTON MORGAN ENGINEERING CO.,
Arthur E. Morgan, Pres.

Dayton, Ohio, Nov. 21, 1921.

EXCEPTIONAL OUTPUT FOR ASPHALT PLANT

With a guaranteed capacity of 1,850 sq. yds. of 2-in. sheet asphalt top mixture per day, an Iroquois Semi-Portable Asphalt Mixing Plant recently produced 4,240 sq. yds. of 1½-in. closed binder in one day.



Fort Fisher Highway, New Hanover County, N. C. Treated with "Tarvia-B" 1915-17-18-19-21, and "Tarvia-A" in 1916.

Wrightsville Turnpike, New Hanover Co., N. C. Treated with "Tarvia-A" 1915, and with "Tarvia-B" 1917 and 1921.

Tarvia
For Road Construction Repair and Maintenance

"The Best Investment the Board Ever Made"

Mr. Addison Hewlett, Chairman of the Board of Commissioners of New Hanover County, N. C., writes, under date of July 25, 1921:

"We have been using Tarvia for surface treating the macadam roads of New Hanover County for the past six years, and we find this treatment satisfactory in every respect.

"Before we started the use of Tarvia we had great difficulty in maintaining our roads, as they became very dusty in dry weather and washed away in wet weather, leaving our road surface full of holes and ruts. Since using Tarvia the surface of the road has been well protected in all kinds of weather, and today our roads have smooth, hard surfaces and our maintenance problem has been very easily solved. The Tarvia treatment is very inexpensive.

"It is unquestionably the best investment the Board of Commissioners has ever made and the Commissioners would not consider for a moment discontinuing Tarvia on our roads."

Additional comments on Tarvia are made by R. A. Burnett, County Superintendent of Roads:

"Tarvia treatments are given to some of our roads every year while other roads, such as the Wrightsville Turnpike, have lasted as long as three years before requiring another treatment.

"These Tarvia treatments have cost us in the neighborhood of $300 per mile per year and have proved to be the best, easiest and cheapest method of maintaining our roads. We have always had the best of co-operation from your engineers * * *.

"We feel that we have a finer system of roads than any other county in the State."

No matter what your road problem may be—new construction, maintenance, or repairs—there is a grade of Tarvia made especially for the purpose. Write for free illustrated booklet describing the various uses of Tarvia.

New York, Chicago, Philadelphia, Cincinnati, Pittsburgh, Detroit, Minneapolis, Dallas, Nashville, Peoria, Atlanta, Duluth, Johnstown, Lebanon, Youngstown, Latrobe, Bethlehem, Elizabeth

The Barrett Company

Boston, New Orleans, Syracuse, Milwaukee, Toledo, Buffalo, St. Louis, Birmingham, Salt Lake City, Bangor, Columbus, Baltimore, Cleveland, Kansas City, Seattle, Washington, Richmond, Omaha

Houston, Denver, Jacksonville

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S.

In a period of two weeks, which included several rainy days, this plant, owned and operated by the Detroit Asphalt Paving Company, turned out 34,336 sq. yds. of 1½-in. closed binder. Figuring on 10 working days, this is an average daily output of 3,433 sq. yds.

These exceptional output records, made in the regular course of a paving operation, indicate the service given by the mixing plant, which was purchased by the Detroit Company during 1920.

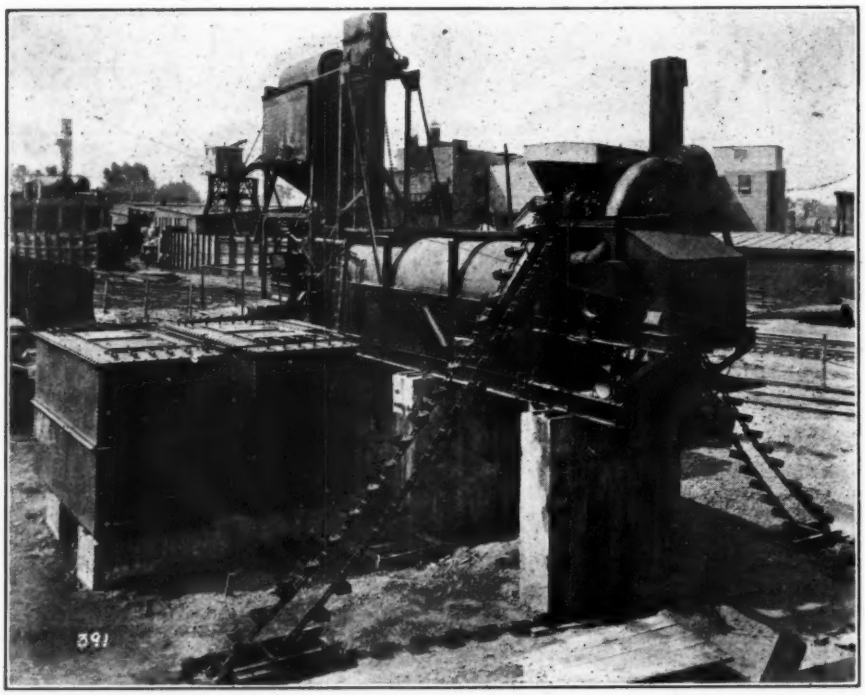
Because of its compact arrangement, the Iroquois 1,850-yd. straight-line plant was selected to meet the exacting requirements of the Detroit Paving Company. Its rated capacity has been consistently exceeded, according to officials of that concern.

The plant is of the same type as the two purchased recently by the City of Philadelphia and which now also are surpassing the guaranteed output.

Although designed primarily as a stationary plant, the Detroit Company plant can be moved from one operation to another with comparative ease. The whole plant is on a single frame and all shafts, gears and other units are held constantly in line.

Not only is the plant capable of greatly exceeding its rated capacity, but it can be operated with a minimum force.

The Iroquois 1,850-yd. plant was produced by the Barber Asphalt Paving Company's works at Buffalo, and the plant of the Detroit company was one of the first of this model made. Incorporated were many features which make for economy and efficiency. The plant is elevated to a height of 8 ft. above the ground level, so that ample room is provided for teams or motor trucks to load.



IROQUOIS SEMI-PORTABLE ASPHALT MIXING PLANT AS OPERATED BY DETROIT ASPHALT PAVING COMPANY.

TRADE LITERATURE

Valves, Governors, Regulators, Etc.—Atlas, Ideal and Victor Reducing Valves, Pump Governors, Pressure Regulators, Hot Water Tank Regulators, Control Valves and Damper Regulators are described in Junior Catalogue No. 21 just published by the Atlas Valve Company, 282 South Street, Newark, N. J. This little catalog of 20 pages gives complete information—illustrates, describes, lists all sizes and gives prices. A copy will be sent free on request to any reader of this publication.

WATER WORKS SECTION

PERFORMANCE OF THE DE LAVAL PUMPS AT THE PUMPING STATIONS OF THE INDIANAPOLIS WATER COMPANY

The Indianapolis Water Company has six pumping stations, two of which are booster stations to overcome friction loss in pipe lines and to increase the water pressure in the eastern part of the city, which is relatively the highest part of the City of Indianapolis. The pumps installed in the last eight years in these stations have been of the DeLaval type. These stations are designated Fall Creek, Riverside, Washington, Broad Ripple, Booster Station No. 1 and Booster Station No. 2.

Fall Creek Station

The entire water supply for the Fall Creek Station is obtained from wells averaging 325 ft. in depth, drilled through rock. At the present time there are 12 wells in active service, yielding a maximum daily supply of 6 m. g. The supply from each well is obtained by means of 4 and 5-in. DeLaval centrifugal pumps, electrically driven by 10 h. p. and 15 h. p. motors located in concrete well pits. The speed of these pumps is 1,730 r. p. m. and they are designed to pump 350 gals. per minute against a total head of 60 ft., with an efficiency of 62 per cent. The discharge pipe lines from these wells empty into a reservoir of 1½ m. g. capacity. From the reservoir the water is pumped into the distribution mains by means of two high-pressure pumps, each of 6 m. g. daily capacity, the one an Allis-Chalmers horizontal cross compound condensing crank and fly wheel pumping engine, the other a 6 m. g. DeLaval pump driven by a 500 h. p. steam turbine. The DeLaval pumping unit consists of two 12-in. single stage double suction horizontal centrifugal pumps. The suction and discharge are 12 ins. in diameter, the speed is 1100 r. p. m., and the pumps are designed to pump 4,160 gals. against a gauge head, including suction lift, of 270 ft., with an efficiency of 75 per cent. This unit was placed in service in January, 1915, and was started and kept in constant operation for 30 days without stop. There has been no replacements of parts on this unit or repairs since it was installed in 1915.

The booster pumps heretofore referred to are all of the DeLaval type. They are used in connection with the Fall Creek pumping engines during "peak" loads in the summer or at other times. Booster No. 1 is equipped with an 8-in. centrifugal pump purchased in June, 1913, operated by a 75 h. p. motor. The pump when operated at a speed of 1120 r.p.m. delivers 2,100 gals. against a head of 88 ft.; efficiency 71 per cent. Two DeLaval pumps operated by 25 h. p. motors are designed to deliver 1,050 gals. per minute against heads of between 88 and 98 ft. Booster No. 2 is equipped with two DeLaval 12-in. centrifugal single stage pumps, each driven by a 250 h. p. motor. When operated under a speed of 1760 r. p. m. the pumps will deliver 4,166 gals. per minute against a head of 162 ft.; efficiency 78 per cent.

Riverside Station

The Riverside Station is the main pumping station of the Indianapolis Water Company and is operated by steam power. The pumping units are as follows:

	m.g.daily capacity
Hamilton-Rarig vertical triple expansion high duty pumping engine	30
Snow vertical triple expansion high duty pumping engine	20
DeLaval steam turbine driven centrifugal pump	30
DeLaval steam turbine driven centrifugal pump	10
DeLaval motor driven centrifugal pump	3
DeLaval steam turbine driven centrifugal pump	6
Total	99

The main water supply for this station is obtained from the filter plant through a 40-in. conduit. The normal daily capacity of the filters is 30 m. g. At this station there are two reservoirs, one of 5½ m. g. capacity and the other 10 m. g., which was completed during the last month and will be put in service before January 1, 1922. At the site of the Riverside Station, supply is also obtained from

43 deep wells, 18 of which are air wells operated by air compressors at the central station. The remaining 25 wells have electrically driven DeLaval pumps located in concrete pits similar to those at the Fall Creek Station.

Turbine No. 1 at the Riverside Station, which has a capacity of 10 m. g. per day, was installed in November, 1911. The speed of the turbine is 9,000 r. p. m., the pump speed is 760 r. p. m. The pumps will deliver 5,600 gals. per minute against a total head of 160 ft. This pump was the first installation made by the DeLaval Steam Turbine Co. for direct pumping into the distributing system. This unit has been in operation at least 75 per cent of the time since it was installed, and it is subject to hard service due to starting and stopping from 5 to 25 times per day to meet the demands of the city on fire pressure. The only replacements which have been made on this unit have been on the high speed bearings and two packing bearings. The oil consumption is about 1 barrel per year.

Unit No. 2 at this station is of 6 m. g. capacity and was installed in September, 1912. The speed of the turbine is 10,700 r. p. m., the pump speed is 900 r. p. m. and is designed to pump 4,200 gals. per minute against a total head of 165 ft. In connection with this unit there is a motor driven booster pump which is used to increase the head for fire pressure service. The piping is so arranged that the booster pump may operate independent of the steam unit and will deliver 3 m. g. for domestic service. This unit in connection with Unit No. 2 will deliver 6 m. g. under fire pressure or 9 m. g. for domestic service. Only one high speed bearing has been replaced on the No. 2 unit since its installation.

The third DeLaval unit was installed in 1920. It has a capacity of 30 m. g. per day. At a speed of 610 r. p. m. this pump delivers 20,800 gals. per minute against a head, including suction, of 160 ft. with an efficiency of 80 per cent. It requires 1,050 brake horse power to operate this pump; the steam pressure at the throttle is 175 lbs. For domestic service it will pump 20,800 gals. per minute against a head of 160 ft. With 1-in. absolute vacuum the guaranteed duty is 130,000,000 ft. lbs. per 1,000 lbs. of dry steam. Under 2-in. absolute vacuum the guaranteed duty is 122,800,000 ft. lbs. Increasing the speed to 735 r. p. m. for fire service, the pump will deliver 30 m. g. against a total head of 250 ft. with an efficiency of 77 per cent. It requires 1705 brake horse power. The guaranteed duty under these conditions and 1-in. vacuum is 135,000,000 ft. lbs. per 1,000 lbs. of dry steam and with 2-in. vacuum, 125,500,000 ft. lbs.

The above data are contract provisions. All tests of DeLaval pumps in Indianapolis have exceeded the guaranteed duty by from 2,000,000 to 5,000,000 ft. lbs.

Washington Station

At the Washington Street Station there are three 4-stage DeLaval pumps, each pump driven by two American Water Turbines. Each unit has a capacity of 5 m. g. per day under a total head of 300 ft. These units are operated 24 hours per day. The only replacements which have been made have been one set of wearing rings and two thrust bearings. These pumps require two barrels of oil per year for lubrication.

Broad Ripple Station

This station is operated during the summer months to give additional pressure during sprinkling hours. It is equipped with one DeLaval 2-stage 5-in. single suction horizontal type centrifugal pump operated by 60 h. p. motor. This pump will deliver 550 U. S. gals. against a head of 230 ft.; efficiency 60 per cent.

The Indianapolis Water Company has purchased and will install within the next month a DeLaval steam turbine driven boiler feed pump.

The satisfactory service which the DeLaval pumps have given, the efficiencies of these units, especially the pumps of larger capacities, the small number of replacements of parts which have been required on the older pumps since they were installed, the relatively quiet running of the Helical reduction gears, the familiarity of the engineers with the operation of the DeLaval pumps, the absence of water hammer in the force mains, all have been factors which have led to the purchase of DeLaval centrifugal pumps by the Indianapolis Water Company.

The pumping units have been installed under the direction of B. J. T. Jeup, Chief Engineer, Wm. Curtis Mabee, Assistant Chief Engineer, and T. C. M. Mauch, the Superintendent of the pumping stations of the Indianapolis Water Company.

WACO WATER WORKS BURNS FUEL OIL UNDER BOILERS

To the Editor:

We have just completed our installation for the burning of fuel oil under our boilers. There will be quite a saving between this and the burning of coal or

lignite, we have been burning in the past. past.

We have paid a price for lignite $4.25 in the bin. Today I closed a contract for fuel oil for one year at $1.35 a barrel, f. o. b. plant.

Taking these two figures for coal and oil and we save possibly $35 per day, or rather $1,000 per month. We were burning about 20 tons of lignite a day against 25 barrels of oil, besides saving the salary of one fireman, which is $110 a month. You can readily see the advantage in regard to saving in the burning of oil.

Very truly yours,

E. L. Fulkerson, Superintendent
Waco City Water Works,
Waco, Texas.

October 5, 1921.

THE CHLORINATION OF NEW ENGLAND WATER SUPPLIES

By William J. Orchard, of Wallace & Tiernan Co., Inc., Newark, N. J.

At present 1996 communities in the United States chlorinate water or sewage or both with Liquid Chlorine. Only 128 or 6 per cent of these are in New England. Twelve are treating sewage, leaving but 116 New England communities chlorinating drinking water. Nearly half, 43 per cent, of these are in Connecticut where 51 communities used Liquid Chlorine to safeguard their water supplies, 24 are in Maine, 18 are in New Hampshire, 11 in Rhode Island, Massachusetts has 9, while Vermont has 3 communities using Liquid Chlorine for their water supplies.

Scoring the states in this country in accordance with the number of communities using Liquid Chlorine and starting with New York in first place with 254 and ending with Nevada in 48th place with but one lone chlorinating community we find Connecticut stands 11th, Maine 25th, New Hampshire 30th, Rhode Island 36th, Massachusetts, 41st, and Vermont, 47th.

A manufacturer of chlorinating equipment naturally asks: Why this relatively small number of communities using Liquid Chlorine in certain sections of New England?

Now, in trying to answer that question, the speaker appreciates that he is skating on thin ice—dangerously near a deep hole labeled "The Johnsonian Controversy," and caution dictates that he skate the other way.

But it is a fact that there is more resistance to the chlorination of drinking water in New England than in any other section of the country. Some of this is due to a firm, honest conviction in the purity and safety of unsterilized water supplies—some of this is due to complete deep rooted faith in the absolute efficacy of storage and water shed patrol—but, in the speaker's opinion, the principle cause for this resistance to chlorination in New England is the marked aversion found in some quarters to the application of chemicals in any form to drinking water. It matters not if, as in the case of sterilization, a barrel full of chlorine will suffice for a Woolworth building filled with water. The objection is to the application of chemicals in any form—no matter what the chemicals may be. This attitude was clearly expressed by one of New England's most prominent engineers who said to the speaker "Up here we don't want medicated waters."

We do not agree with the opponents of chemical treatment but we have absolutely no doubt of their sincerity. We can only hope that they will believe that the rest of us are equally sincere as we try to persuade them to change their minds.

Boston, for instance—or rather the metropolitan district—is the only large community west of the Rockies that does not chlorinate its water supply as an added precaution.

But Boston points to its low typhoid records with justifiable pride, and takes the stand that perhaps other cities have to chlorinate their water supplies to obtain low typhoid rates, but Boston can get a low typhoid rate without chlorination, so "Why put chemicals in the water?"

Of course then comes the question of the potential danger of an untreated supply, especially where reservoirs are easy of access, but here again we approach the controversial and turn the page for such is not the purpose of this paper. But, as though to compensate for some of its seeming neglect of the manufacturers of chlorine and chlorine control apparatus, New England has made many contributions to the development of the process of chlorination.

As time brings to light more facts concerning its nativity, it seems more and more likely that the experimental work of Sedgwick and Phelps at the Massachusetts Institute of Technology in Boston a score of years ago was the corner stone of our present practice in the Chlorination of Water Supplies.

It was at Torrington, Connecticut, that Tiernan—then struggling with Wallace in the development of a practical ozone gen-

erator for the sterilization of water—worked with Phelps in checking a water-borne epidemic, made use of bleaching powder to sterilize the water supply and caused them to transfer their energies from ozonation to chlorination. It was at Stamford, Conn., that the first automatic chlorine control apparatus was developed, thanks to the patience and co-operation of the late and highly esteemed manager of the Stamford Water Company—Mr. E. L. Hatch, one of the earliest and always one of the staunchest supporters of chlorination.

The first recorded reduction in color obtained by treating water with chlorine was secured at Branford, Conn., by Minor, of the New Haven Water Company where, under his patronage and with his keen interest, an entirely new type of equipment, that holds great promise, has been under test for nearly a year. It was at Exeter, N. H., that Weston first introduced liquid chlorine to water before the coagulant in order to reduce alum requirements—a procedure that has now been adopted with success by many operators. And at the Abattoir at Brighton, Mass., Liquid Chlorine was first used to sterilize wash water used about the packing plant—a procedure that is now universal in the packing industry. At Waterbury, Conn., the Y. M. C. A. was one of the very first to use Liquid Chlorine to sterilize swimming pool water.

So you see New England has a considerable responsibility for the position in which the process of chlorination now finds itself and has contributed almost as much to this as it has to other developments in the field of sanitation.

There is much that New England still can do. We seem to be at a turn in the road where new standards of water are to be developed or else new interpretations placed on existing standards. With the increased attention being given to the chemistry of colloids and to the electrolytic dissociation theory as exemplified by the interest in Hydrogen Ion concentration, chlorination presents a wide field for study. And in that study the wholehearted assistance of all New England water works men is needed.

In New England, more than in all the rest of the country, are located the men who, since the late eighties, have guided the development of water treatment to its present stage. Their help is needed in the developments that are to come. That help will speed the day of arriving at a proper appreciation of the merits of various modes of water supply protection.

The foregoing is from a paper presented by Mr. Orchard before a recent meeting of the New England Water Works Association.

OPERATING AND NEW CONSTRUCTIONAL FEATURES OF BALTIMORE WATER WORKS

By James W. Armstrong, Filtration Engineer, Baltimore Water Department, Hillen Road, Baltimore, Md.

Baltimore is at present dependent for its water supply upon the Gunpowder River, a relatively small stream, whose flow is sometimes less than the city's requirements for water, but from a sanitary point of view it is more fortunate than many cities, whose supply is taken from streams too large to warrant any kind of sanitary control.

Water Shed Control

The Gunpowder Watershed, comprising 306 square miles, lies almost wholly within Baltimore County, Maryland, only a small area near its source lying in Pennsylvania. It is thus possible to have under fairly close supervision the activities of the entire watershed, and to control absolutely all streams for a considerable distance above the city. The department believes, that as far as possible, it should control its entire water supply from the time it is given up by the clouds until it is drawn from the pipes for use.

Obviously complete control in a thickly settled area is not possible, but very much has been done in the past few years to prevent contamination of the city's water supply. First—by the purchase of land along the streams. The city now owns between 2,000 and 3,000 acres of land, and when the new improvements are completed will own 5,000 or more acres, and will have absolute control of both banks of the river as far north as Phoenix, which lies about 19 miles north of Baltimore. Second—by moral suasion, an effective method of water purification not usually described in technical papers, but nevertheless, one that should receive more attention from those in charge of the water supply of cities.

For years Baltimore has had an inspector who has systematically visited every premise on the Watershed, and by good natured persistence has been the means of getting rid of the worst sources of pollution. His policy has been to lay before the people the importance of pure water supply. Most of them see the point, and many have been willing to spend a considerable amount of money to elimi-

nate sources of pollution. Probably the most effective work has been done in supervising and preventing the spread of typhoid fever. Every case is reported by the State Board of Health to the Department, and the inspector at once visits the premises to see that there is no possibility of contaminating the water supply. The necessary sanitary instructions for care of the patient are given, and disinfectants are supplied. The inspector does not drop the case with a single visit but follows it to a conclusion. In this way everything possible is done to free the water supply from a suspicion of typhoid.

Forestration

Baltimore County is full of hills. Many of them are covered with clay which at times of heavy freshets is washed into the river, making the water very turbid. On one occasion it reached Montebello Filters with a turbidity of over 5,000, and it frequently exceeds 1,000. Such water is difficult and costly to treat.

In order to prevent the washing of the soil and to retain as much water in the earth as possible, the Department aims to cover all ground with grass or timber. They have already planted over a million trees, mostly white pine and spruce, and as soon as the new improvements are completed, they propose to continue the plantings over most of the ground owned by the city.

Need of Greater Supply

During the year 1910, there were 6 consecutive months when the flow of the Gunpowder River was less than 75 million gallons per day, and there was one month when it dropped as low as 54 million gallons per day. The recurrence of such a condition at the present, when the daily consumption is between 90 and 100 million gallons, would prove a calamity to the city, as it is not possible on account of the extremely high suction lift imposed upon the pumps, to withdraw water much below the existing level.

For a number of years the engineers of the water department have had a very keen realization of the situation confronting the city, and in their effort to find a solution of the problem, have investigated every source of supply from the Susquehanna to the Potomac.

It seemed best to develop the Gunpowder River, the existing source of supply, to its ultimate possibility before going to other sources. Accordingly, it was planned to create a large impounding reservoir at Loch Raven by raising the existing dam from elevation 188 to 240, a distance of 52 ft. Raising Loch Raven reservoir 52 ft. would permit Montebello Filters to be fed by gravity, but in order to do so, the existing tunnel would have to be relined or a new one built.

In order to use the existing tunnel and pumping station, a plan was adopted of building a balancing reservoir near Loch Raven, which increased the head on the tunnel about 8 ft., and offers a satisfactory means of equalizing the flow of water admitted from Loch Raven. This work is now under construction, and will cost at contract prices based upon estimated quantities about $50,000.

Loch Raven Dam

The first step toward carrying out the new improvements was taken in March, 1921, when a contract was awarded for the raising of Loch Raven Dam 52 ft. Fortunately, the old dam had been built with foundations fully able to carry the new structure. When completed, the new dam will have an over all length of 637 ft., an ogee spillway section 288 ft. long, and will contain about 40,000 cu. yds. of concrete. The gravity type of dam was selected instead of the hollow or Amburson type, as offering greater security against the action of frost and ice, extending over a long term of years, and as providing a better means of raising to a higher elevation at some future date.

A feature that complicated construction, was the necessity of providing an additional gate chamber as a terminal for a new tunnel, which it will be neecssary to build before Montebello Filters can be fed by gravity.

Impounding Reservoir

The raising of Loch Raven Dam will form a reservoir covering an area of 2,390 acrse, and having a capacity of about 23 billion gallons. It will extent north as far as Phoenix, and will necessitate abandoning the cotton mills at that place. It will practically wipe out the picturesque village of Warren, and the mills of the Warren Manufacturing Company.

About 6 miles of county road and 2 or 3 large highway bridges will have to be built in order to replace those destroyed by flooding.

A large force of men have been engaged in cutting timber from the area to be flooded since April, 1920, and considerable work still remains to be done.

Loch Raven Tunnel

Water is conveyed from Loch Raven to Montebello Filters through about ½ mile of 10 ft. cement lined steel pipe, and 6½ miles of 12 ft. tunnel cut through solid rock. Some portions of the tunnel are unlined, some are lined with brick, and

others, the weakest portions, were relined with reinforced concrete in 1914. Tests made last December revealed the fact that the tunnel leaked badly at 2 points, under pressures far below that which would be put upon it by the water impounded back of the new dam.

The weakness of the existing tunnel makes it very desirable to do one of two things; either to reline it with reinforced concrete, or to build a new one. On account of the large volume of water consumed, it is impracticable to shut down the tunnel long enough at one time to do the relining.

A new tunnel is eminently desirable, and could probably be built for about $4,000,000. Such a tunnel would insure the safety of the city's water supply, would permit the relining of the old tunnel, would permit the filters to be supplied directly by gravity, would effect a saving at the present time of over $100,000 a year for power, and would provide a greater impounding reservoir without resorting to pumping, as the friction losses between Loch Raven and Montebello would be reduced four-fold.

The cost of a new tunnel at the present time, however, is prohibitive, and in order to use the tunnel as it exists today and to insure it against pressure of water back of the dam, and to permit adequate control of the water being withdrawn by the pumps, some means had to be provided for its proper regulation.

Balancing Reservoir

A knowledge of operating conditions is essential to an understanding of the new balancing reservoir now under construction. The pumps at Montebello are set in a pit 24 ft. below the ground, and have their center line about 5 ft. above the normal water surface at Loch Raven. Friction losses between Loch Raven and Montebello lower the water level in the suction well, a further distance of from 3 to 9 ft. The present method of operation is to open wide all Loch Raven gate valves, and to control the flow of water by means of the pumps at Montebello.

If, however, the water level at Loch Raven should be raised 52 ft., as it will be on completion of the new improvements, it would be impossible to open the gates at the dam, without subjecting the tunnel to the full hydrostatic pressure of the water back of the dam, and it would be impossible to control, with sufficient accuracy, the flow of water by means of the gates at Loch Raven, as too wide an opening would subject the tunnel to pressure, or too small an opening would cause the pumps to lose suction. It was, therefore, determined to obviate this difficulty by converting an old quarry pond located over the tunnel near Loch Raven, at a point where leakage occurred during the test made last December, into a small balancing reservoir whose water surface will be maintained at elevation 200.

A shaft sunk to an intersection with the tunnel through this reservoir, will thus permit water to flow freely in and out, and it is obvious that if it is admitted from Loch Raven, whose surface is 30 ft. above that of the balancing reservoir, at a rate greater than that required by the pumps, the excess will pass over a spillway into a nearby stream, and the tunnel will be relieved of pressure.

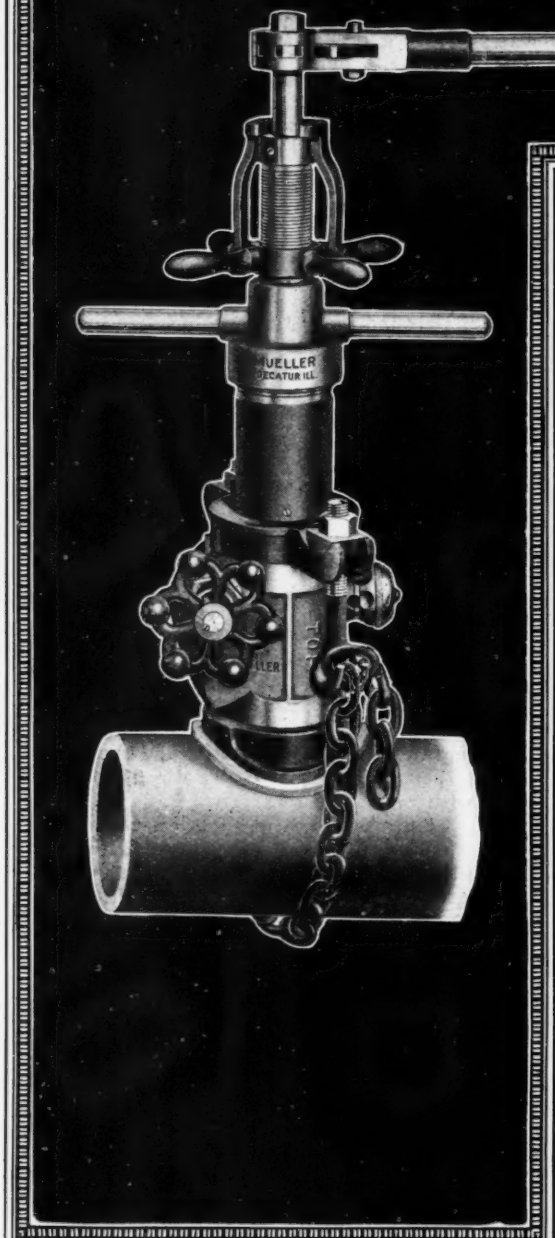
If the reverse condition holds, and the pumps should require more water than was being supplied, the deficiency will be taken from the balancing reservoir, and there will be no danger of the pumps losing suction.

While the primary purpose of building the balancing reservoir was to obtain a means of controlling the flow of water, that would permit the use of the old tunnel without subjecting it to pressure, and to utilize the present pumping station, it further serves the purpose of reducing the suction lift of the pumps 8 ft., thereby effecting a saving of about 20 per cent of the total cost for power.

The balancing reservoir will have a capacity of about 10,000,000 gals. in the upper 5 ft., and will be formed by building an earth dam across a ravine. It will have a crest of 15 ft. wide and a 3 to 1 slope on the upstream face, and 2 to 1 on the downstream face. It will be built without core wall, but will have a toe wall extending to rock and will be faced with concrete.

Surge Tank

Power for operating the pumps is transmitted through underground cables, from the Monument Street Power House, where connection can be made either with the transmission lines from McCall's Ferry Hydro-Electric Plant, or from any of the large generating stations owned by the Consolidated Gas & Electric Co. One of the difficulties of operating the pumping station with power received over long distance lines, is that there are occasional interruptions in the service. If power goes off the line for a single instant, all the pumps are automatically thrown out of service, and the sudden stopping of pumps causes water hammer due to the sudden checking of a column of water 7 miles long, and 12 ft. in diameter.



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Fortunately, the enclosed shaft forming the suction well is amply strong and has a great air cushion to help withstand the water hammer. It is believed, however, that it would be much safer if the shock could be avoided, and in order to overcome this, a shaft is to be sunk intersecting the tunnel line just before the pumping station is reached. The top of this shaft will be left open at elevation 200.5 or just ½ ft. above the level of the spillway of the dam at the balancing reservoir. In case of a surging of water in the tunnel, it will simply overflow this shaft and discharge into the washwater reservoir at Montebello.

Low Lift Pumping Station—Economy of Motor Driven Centrifugal Pumps

The low lift pumping station is located at Montebello, is circular in form and 36 ft. in diameter. The pumps are arranged radially around a closed suction well 16 ft. in diameter, which forms the terminus of the Loch Raven Tunnel. They discharge into a 6½ ft. concrete conduit formed in the foundation wall of the building.

There are 5 different pumping units which operate against a total head of about 40 ft. The combined capacity of the pumps is about 240 million gallons per day, but the different units vary in capacity, and advantage is taken of this fact to secure the most economical combination necessary for the required volume of water. The pumps are operated by 3-phase, 25-cycle, 500-volt induction motors, ranging from 275 to 600 horse power. The power supplied to each motor is registered by a graphic watt meter.

An interesting feature of operating record is the low cost for labor as shown during the past 6 years. The station is operated by 3 shifts of 8 hours each, and never, since the plant was put in service, has more than one man been employed on a shift. The small number of attendants required to care for motor driven centrifugal pumps is sometimes lost sight of in comparing the economy of different types of pumping machinery.

Chemical Treatment

As it is impossible to get a railway siding at the Filter plant, all chemicals are transported by truck from the B. & O. siding, which is approximately two miles away. On reaching the plant both lime and alum are passed through a small crusher and elevated by means of a bucket conveyor into overhead bins, which are capable of holding something over 1,500,000 lbs. From these bins the chemicals are drawn by gravity into buckets which are pushed along over-head trolley tracks, to the dissolving boxes, where they are put in solution and prepared for addition to the water.

A 96x48 in. Venturi Meter placed between the pumping station and the filters is used as a means of determining the rate of applying chemicals. The chemicals were automatically controlled at first, but as the pumping rates vary by fixed amounts, it was found to be less trouble to operate the feed controllers manually, and the automatic features were abandoned.

Mixing and Coagulating Basins

After the application of the alum to the water, it passed backward and forward through the mixing basin where it is thoroughly incorporated with the water. The basin is constructed with baffles of the around-the-end type, which are instrumental in securing a large well formed floc which settles out readily in the coagulating basins. There are two coagulating or settling basins, each of which has a capacity of about 8,000,000 gals., and, figured on displacement, they have a normal capacity of about 3 hours. From 90 to 95 per cent of the sediment is removed from the water and settled out in these basins.

Filters

Montebello Filters are of the mechanical or rapid sand type, and consist of 32 separate units, each having a daily capacity of 4,000,000 gals. or a total capacity of 128,000,000 gals.

They are situated in surroundings of more than ordinary beauty, and the plant is housed in red brick buildings, covered with green tile roof.

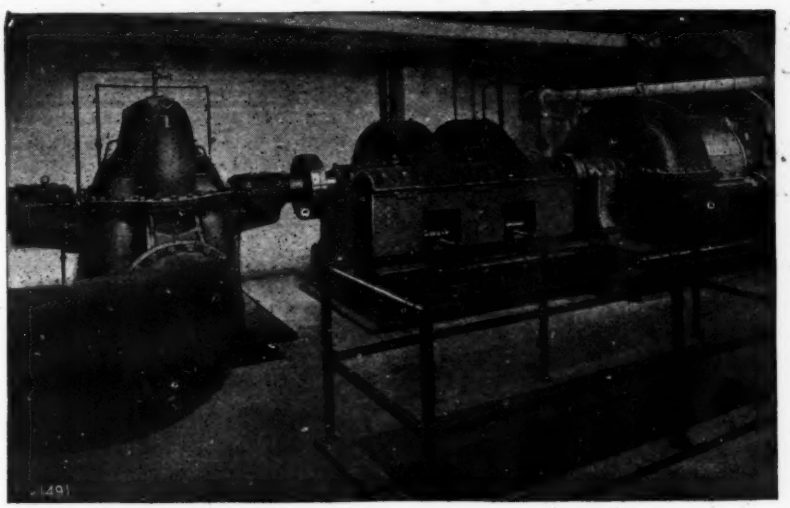
The filters are located above basins which are directly connected with the Filtered Water Reservoirs, all of which have a combined capacity of a little over 17,000,000 gals. While the capacity of these basins is relatively small, their value has been demonstrated many times, as we have been able to shut down the plant for short intervals without interrupting the supply. The application of liquid chlorine to the water as it enters the Filtered Water Reservoir is the last step in the process of purification.

New Filters

During the summer of 1919, the filters were taxed to the utmost, and if money had been available at that time, a new plant in all probability would be a reality today. But, due to a careful and systematic conservation plan, and to decreased use for manufacturing purposes, the water consumption has been reduced to such a

De Laval

Pumps Supply the Nation's Water



DE LAVAL centrifugal pumps handle approximately 2,000,000,000 gals. per day of the water used by American municipalities.

The city of Toledo has recently installed a 30 million gallon per day geared steam turbine pumping unit to operate under a maximum of 192 ft. head, as shown in the accompanying photograph. This installation has been highly successful and the duty guarantees were exceeded by an ample margin on the official test.

The steady trend toward De Laval steam turbine driven centrifugal pumps for American municipalities is due to one great fact, viz: that

Water is handled at less total cost by De Laval Pumps than by any other means.

You can satisfy yourself as to this fact by investigating installations of De Laval Pumps in leading cities, such as Pittsburgh, Cleveland, St. Louis, Montreal, Toronto, Philadelphia, etc.

We will gladly supply further information or submit estimates and guarantees on apparatus to meet your requirements. Ask for Catalog W-92.

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point that the design of a filter plant can be postponed until the more urgent need of a greater supply can be met.

Tentative plans for the new filters, involving a completely equipped plant have been made. They contemplate a number of new features, among them a plant for the manufacture of alum. The new structures will be built on ground acquired for the purpose, adjacent to the present plant on the opposite side of Hillen Road. It is expected that before long, the new plans will be worked out in brick and concrete.

The foregoing paper by Mr. Armstrong was presented at the 1921 annual meeting of the American Society for Municipal Improvements.

MUNICIPAL HYDRO ELECTRIC PLANT AT FORT DODGE, IA., EARNS 12% NET

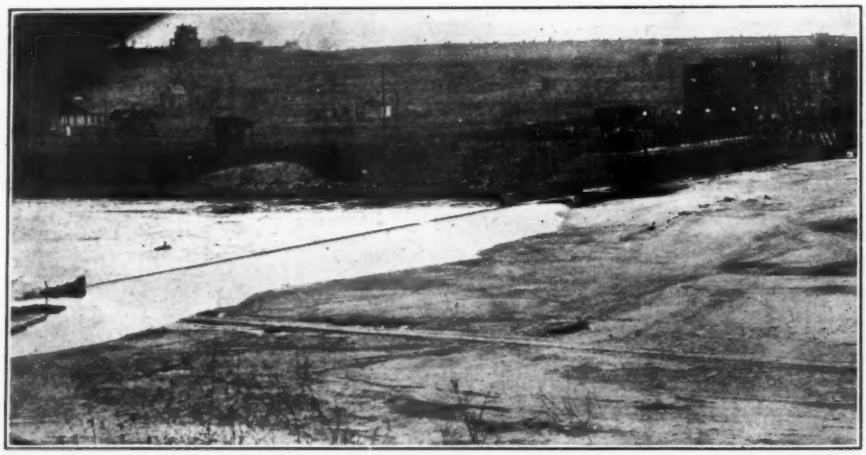
By R. E. McDonnell, of Burns & McDonnell, Consulting Engineers; Interstate Bldg., Kansas City, Mo.

(Editor's Note:—About 4 years ago Burns & McDonnell designed a municipal hydro-electric plant on the Des Moines River for the City of Fort Dodge, Iowa. In conducting the bond campaign for the funds for the construction, the engineers stated publicly that the investment would be sound financially and should yield a net return to the city, on the investment, of about 10 per cent. After 4 years of operation, an analysis has been made of the operating expenses, cost, etc., and it is found that the project has a gross return of 30 per cent and a net return, above operating expenses, interest on the bonds, depreciation and sinking fund of 12.18 per cent. The lake impounded above the dam is also utilized as a pleasure resort, many summer cottages being built on the bluffs of the river where motor boating, fishing and bathing are enjoyed.)

Cities do not always leave their undeveloped resources to be handled by private companies who make excellent profits out of the development. Fort Dodge, Iowa, 4 years ago, voted bonds and built its own municipal hydro-electric plant across the Des Moines River near that city. While it was anticipated that the financial investment would be profitable to the citizens for the saving of power it would develop, that was not the sole reason for building the dam. One of the chief reasons was the creation of a lake that could be utilized for pleasure purposes. The municipal dam has been successful from both standpoints and after 4 years of operation, the financial returns have proven so much greater than the expectations that a brief review of results may be of interest.

The project had been advocated by private parties which sought a franchise but upon the assumption that if the project was financially sound for private parties it ought to be equally sound for the municipality, the citizens under the leadership of Mayor John F. Ford, decided to vote bonds for the project to be handled entirely by the municipality.

The construction difficulties encountered were numerous because of various floods occurring during the construction period, but about 4 years ago the hydro-electric development was placed in operation, the city utilizing part of the current for the operation of its own water works plant and the surplus current being sold to the local light and power plant, whose rates



MUNICIPALLY OWNED HYDRO-ELECTRIC PLANT ON THE DES MOINES RIVER AT FORT DODGE, IOWA.

2-inch Service Pipe cast bell down in 9-foot lengths

Cast Iron Service Pipe

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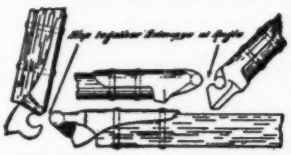

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were correspondingly low because of the purchase of the surplus electric current. While the city was not owner of the local distributing lighting property, the citizens benefited through reduced rates because of utilizing the municipal hydro-electric plant.

The opponents of municipal ownership in the operation of public utilities must receive a severe shock when they analyze the excellent financial showing made by this municipal plant, operated by John W. Pray, superintendent of the municipal water and hydro-electric plant. The net profits are so large that the municipality is in grave danger of being charged with profiteering.

The dam is 412 ft. wide, 18 ft. above bed rock and is a reinforced concrete structure. The project was built under contract following the plans and supervision of Burns & McDonnell, Consulting Engineers of Kansas City, Mo. The engineers also conducted a bond campaign under the auspices of the Commercial Club and at public meetings, illustrated lectures were given, describing fully all of the features of the proposed development. Four years ago the project was placed in operation. It is gratifying to know that the return on the investment exceeded the claims made by the engineers during the campaign for the bonds.

The turbine and generators are in duplicate, with total capacity of approximately 2000 H. P. The entire cost of the project was $160,000. The bonds are for 25 years, bearing 4½ per cent interest. Of the $160,000, $100,000 was raised by bond issue and the balance of the $60,000 used for construction was paid out of the earnings from the municipal water works plant where a portion of the electricity is used for the operation of the pumps.

The gross revenue, operating expenses and net revenue from April, 1920, to April, 1921, are as follows:

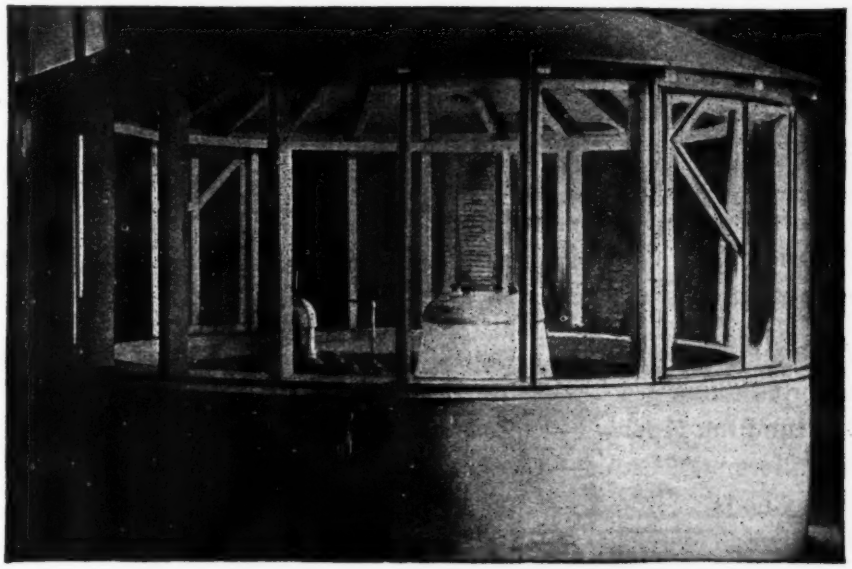
	Gross	Expenses	Net
April	$2,854.03	$1,741.16	$1,112.87
May	3,806.41	815.80	2,990.61
June	4,254.27	685.07	3,569.20
July	3,710.86	1,064.80	2,646.06
August	3,372.06	1,603.23	1,768.83
September ...	4,179.13	909.37	3,269.76
October	3,324.03	935.37	2,388.66
November ...	4,535.70	1,539.33	2,996.37
December ...	3,769.28	645.50	3,123.78
January	3,967.76	710.37	3,257.39
February ...	3,788.83	665.44	3,123.39
March	3,968.61	978.64	2,989.97
	$45,530.97	$12,294.08	$33,236.89

The above gross revenue shows a gross return on the investment of about 30 per cent. Allowing a depreciation on the assumed life of the dam as 60 years, at 3 per cent, and a depreciation of 3 per cent with the life of 25 years on machinery and power equipment, the total annual depreciation fund is $2,220. The sinking fund for discharging the entire original investment in 25 years amounts to an annual sum of $4,320; the bond interest at 4½ per cent amounts to $7,230, giving a total, including operating expenses, of $13,740.

Total of interest, depreciation, sinking fund and operation...$26,034.08
which deducted from the gross revenue of $45,530.97, leaves a net clear profit of.....$19,496.89
or a net revenue of 12.18 per cent on the total investment.

The question naturally arises as to how many privately-owned undertakings are able to show better than 12 per cent net on the investment. At this rate of return, the city will have the project entirely free from debt before the expiration of the bonds and toward the close of the period at which the bonds will expire, on account of reduced interest and sinking fund, the project will be paying the city over 20 per cent net on the investment. All of this is accomplished in spite of selling the surplus electric current at the very low rate of 0.085 cts. per kilowatt hour and the water works pumping plant is charged for its current at the rate of 1c kilowatt hour for power used there.

In view of the splendid investment by the City of Fort Dodge, other cities throughout the country should not hesitate to undertake and develop their own valuable water powers. Many projects of equal merit to the one at Fort Dodge lie undeveloped and while private companies are clamoring for high rates and are having a struggle to get funds for financing these projects, the municipalities themselves should utilize their own credit and develop these industries. It is of interest to see that the City of Fort Dodge utilizing its own credit borrows its money at 4½ per cent for this development and a private company would have undoubtedly had to pay at least twice this rate for funds to carry out the same development. This difference between the credit of the city and credit of the private company, itself, makes the rates of many privately-owned light and power plants 30 to 50 per cent higher than they otherwise would be. By reason of having power available at a low rate a strong inducement exists for securing new industries. The lake formed above the dam has transformed Fort Dodge into a pleasure resort now enjoyed by thousands, so both from the standpoint of pleasure and profit, it is a decided success.



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CAREFULLY PLANNED LAYOUT SPEEDS CONSTRUCTION ON NORTH CAROLINA ROAD JOB

A carefully planned construction plant layout has speeded up the construction of State-Aid Project No. 510, Guilford-Forsyth Counties, located between High Point and Winston-Salem, N. C., and the contractor is making unusually good progress on the work, says the North Carolina Highway Bulletin.

Royer-Ferguson Company, Inc., of Roanoke, Va., have the contract for the construction of this highway and began work on July 11th. Approximately $428,000 will be expended in the building of this project which embraces 10.59 miles of road, the construction being of plain concrete, 18 ft. wide, 6 in. thick on the edge, and 8 in. thick in the center.

By closely coordinating the operations of the various units of his outfit the contractor is making steady progress on the job, averaging about 1½ miles per month, and expects to finish his contract well within the specified time limit.

Central Proportioning Plant

All materials are proportioned at a central plant which is located adjacent to a railroad siding in High Point and which is about 1 mile from the beginning of the work. Arriving by rail, the sand and stone is unloaded directly from the hopper cars into pits beneath the tracks, while the cement is unloaded into the warehouse. A "Brownhoist" 15-ton revolving locomotive crane is used to transfer the sand and stone from the unloading pits to the stock piles, or into the storage bins, as necessity may demand. These bins have a capacity of 100 cu. yds. of material and are fitted with automatic chutes for measuring the proper quantity of aggregates.

Hauling Materials

The contract for hauling the raw materials from the proportioning plant to the job was sublet to a local transfer company on a per-ton-mile basis. The entire distance to be covered is over the paved streets of the town which made the use of rubber tired trucks imperative. "Acme" trucks, each pulling a "Troy Trailer," are used in transferring the proportioned aggregates and the method is proving very satisfactory. Each truck carries three "Lakewood" steel batch boxes, having an individual capacity of 22 cu. ft. of dry material, while the trailers are loaded with four similar boxes. Upon arrivel at the proportioning plant the batch boxes on the truck are loaded with the correct proportion of cement from the warehouse; the truck is then detached from the trailer and turns, coming under the chutes of the

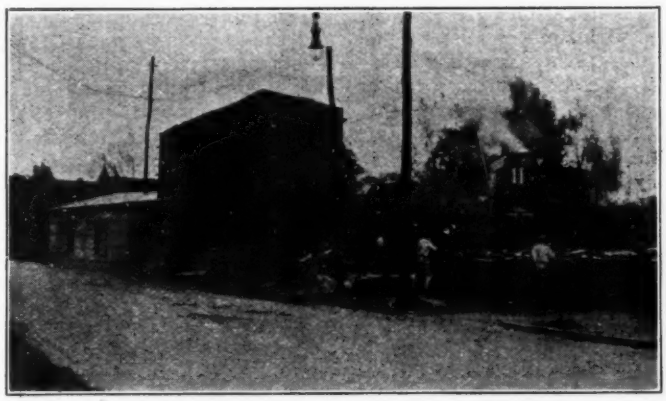

FIG. 1—CENTRAL PROPORTIONING PLANT ON CONCRETE ROAD CONSTRUCTION BETWEEN HIGH POINT AND WINSTON-SALEM, N. C.

storage bins. At the same time the boxes on the trailer are being loaded with cement, those on the truck are being filled with correctly proportioned aggregates. Following this operation the truck is again connected to the rear end of the trailer and pulls the latter under the driven under the gantry and by means of a chain hoist the boxes are transferred to the cars of the industrial train, an empty box being conveyed from the car to the truck at the same time. As soon as the loaded boxes on the truck have been placed on the cars the trailer is

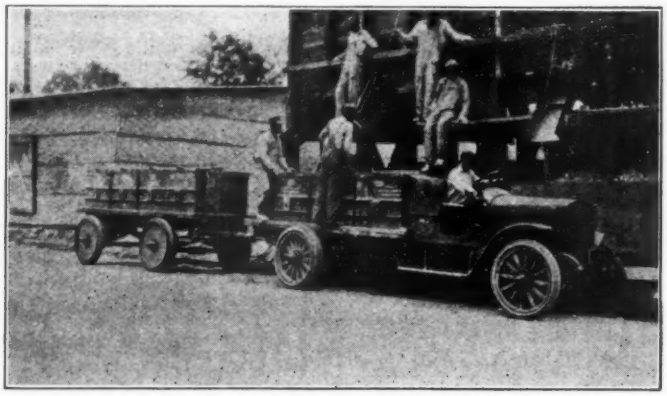

FIG. 2—LOADING TRUCK AND TRAILER FROM STORAGE BINS.

chutes of the storage bins where the trailer is loaded with stone and sand. This method eliminates the necessity of reversing the trailer, which is fitted with a drawbar in each end, thus reducing the time required for loading, averaging at the present time about 4 minutes.

As previously stated, there is a haul of approximately a mile between the central proportioning plant and the beginning of the project but as it is entirely over paved streets the distance is covered very quickly by the trucks.

pulled under the gantry to be unloaded, and the truck is detached and after being turned, is again attached to the rear end of the trailer, ready for the return trip to the proportioning plant. By the installation of an "Ingersoll" air-hoist, which the contractor has on the ground, the number of men required at the gantry will be reduced from 6 to 2 while the operation of changing the boxes will be hastened. One and one-half miles of track are available for the industrial railway, which parallels the job, and when this limit is reached the gantry will be moved forward on the new pavement and the track laid ahead of it. By the time this move is necessary the pavement will have

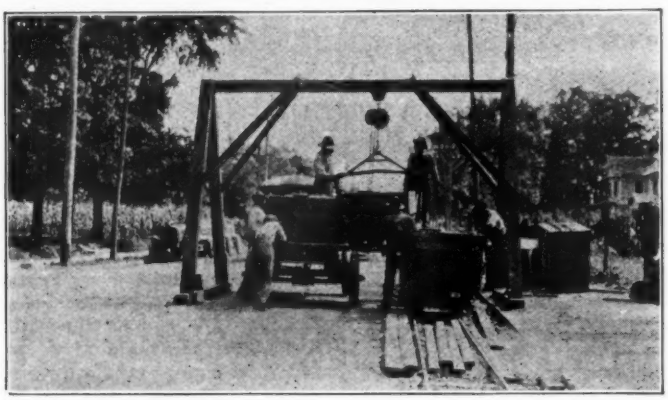

FIG. 3—TRANSFERRING BATCH BOXES FROM TRUCK TO INDUSTRIAL TRAIN.

Industrial Railway

Fig. 3 shows the method of transferring the batch boxes from the trucks to the industrial railway. The loaded truck is

cured sufficiently to bear traffic and the materials from the proportioning plant will be hauled over it.

Three trains, 2 of 8 cars each and 1 of 6 cars, are used at present in supplying the mixer with materials from the transfer point, this number to be increased if found necessary. Each car carries two batch boxes, making 16 batches to the train. Motive power is furnished by "Burton" 5-ton industrial, gasoline driven, locomotives. The movements of the trains have been carefully timed so as to furnish a constant supply of material to the mixer at the same time avoiding an over-supply. Two sidetracks are included in the layout, one at the transfer point and the other ahead of the mixer. After being loaded, the first train of the day pulls up with the mixer, while the second is run out of the side track near the gantry and down to the transfer point to be loaded. Upon arriving at the mixer the first train cuts off the two rear cars and runs ahead on the main line to a point past the switch of the siding ahead of the mixer. By the time that the third train, consisting of 6 cars, which has been standing on the siding, is shifted back opposite the mixer the 2 cars previously dropped by train No. 1 have been emptied and these are coupled to train No. 3 and the train run back to the siding near the loading point where it remains until train No. 2 is started to the mixer. As soon as the former train is clear of the mixer the first train backs down and is unloaded after which it runs up into the siding and awaits the arrival of train No. 2. This system supplies a steady flow of materials to the mixer and the maximum output is secured.

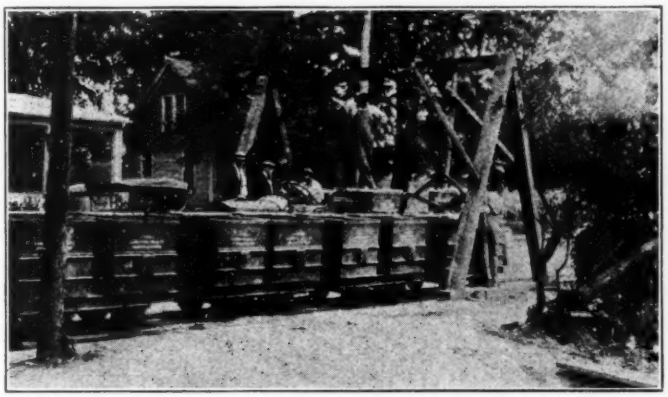

FIG.4—ANOTHER VIEW AT THE TRANSFER POINT.

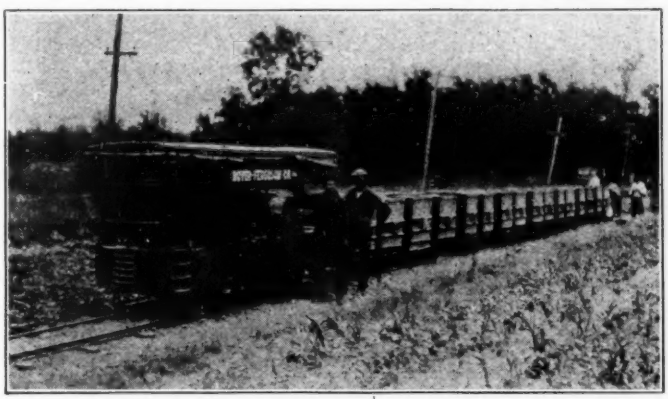

FIG. 5—A VIEW OF THE INDUSTRIAL RAILWAY EQUIPMENT.

Concrete Mixing

The concrete is mixed in a "Lakewood" type E-14 paver of 4-bag batch capacity, driven, as is all of the other equipment on the job, except the locomotive crane, by a gasoline engine. The batch boxes are

automatically unloaded from the cars and the contents dumped into the skip of the mixer by means of an ingenious derrick arrangement on the front of the mixer. The motion of lowering the empty skip is transmitted through sheaves to the derrick and raises a loaded batch box from the car by means of hooks engaging lugs on either side of the car. The box is then swung over the skip and emptied after which it is swung back into position over the car and lowered by the action of raising the loaded skip. This is another point in the general scheme whereby the contractor has substituted mechanical means for labor.

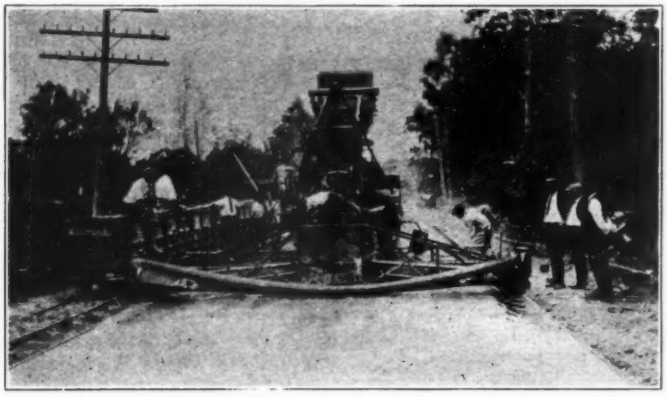

FIG. 6—UNLOADING THE INDUSTRIAL TRAIN AT THE MIXER. LAKEWOOD FINISHER IN THE FOREGROUND.

Finishing

In a great deal of concrete road construction very little attention is paid to the forms that are used which results in the edges of the finished pavement presenting a ragged appearance. On this job, however, the contractor has been very careful to secure forms which will insure a finished appearance to the roadway. By using "Blaw-Knox" steel forms of the heaviest type the contractor is enabled to run the "Lakewood Subgrader" ahead of the mixer to prepare the subgrade prior to laying the concrete pavement. The machine rests directly on the forms and is pulled along the subgrade by means of a "Kelly-Springfield" gasoline driven roller. After being brought to grade the subgrade is thoroughly rolled and sprinkled before any concrete is poured, and with the exception of the mixer, which furnishes its own tractive power, no hauling is done on the subgrade after it has been prepared to receive the concrete.

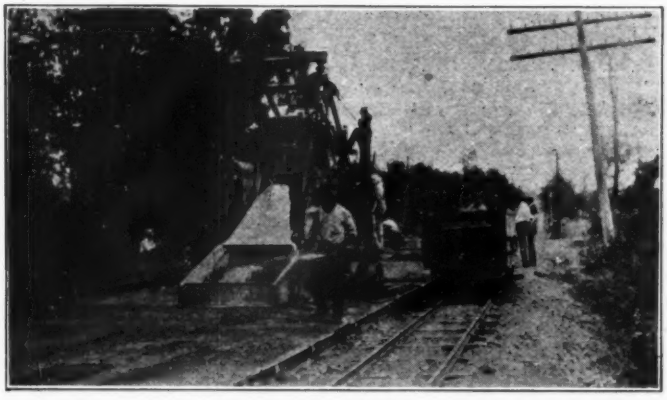

FIG. 7—SPRINKLING THE SUBGRADE AHEAD OF MIXER.

Still carrying out the idea of using modern equipment and doing away with labor the contractor is using a "Lakewood Finisher" to give a smooth, easy riding surface to the pavement. This machine also travels along the steel forms.

Curing

After the pavement has been finished it is kept covered for 24 hours with strips of burlap, thoroughly saturated with water to prevent too rapid drying. At the end of this time, the pavement is covered with a layer of earth which is also kept saturated for a period of 21 days or longer, after which it is cleaned off and the road opened to traffic.

Throughout the entire job a spirit of co-operation has seemed prevalent and a more smoothly functioning organization is seldom seen. Mr. R. Stuart Royer, president and general manager of the contracting firm, a civil engineer of wide experience, has established an office in High Point and spends the major portion of his time on the work. The superintendent, Mr. Oates, has had long experience in this line of work. Representing the State Highway Commission on the job are Mr. J. W. Mills, resident engineer, and Mr. J. M. Hobbs, inspector, who is on the engineering staff of Mr. John D. Waldrop, District Engineer, in charge of all work in the Fifth District.

To summarize, a more complete equipment or a more carefully planned layout for a job of this kind is not to be found in North Carolina and it is a credit both to the contractor and to the engineer of the Lakewood Engineering Company who planned it. If the job is completed in the same careful manner in which it has been started, and there is no reason to doubt but that it will be, this road will be one of the best, if not the best, examples of plain concrete highway construction to be found in the State. By reason of its location, between two of the most progressive cities of North Carolina, it will be called upon to bear heavy traffic and will thus afford an opportunity for further study of the life and wearing qualities on concrete highways.

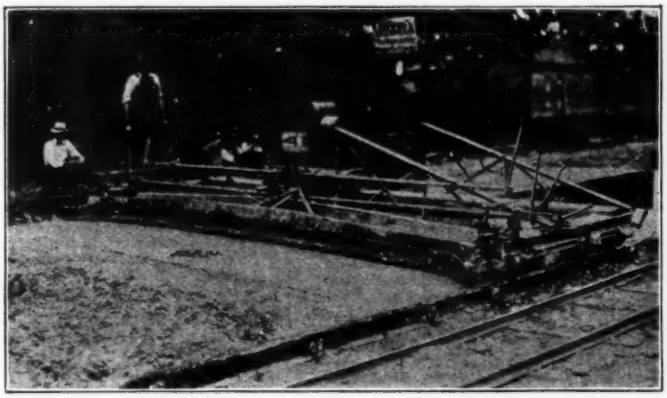

FIG. 8—LAKEWOOD FINISHER USED TO GIVE SMOOTH SURFACE TO FINISHED PAVEMENT.

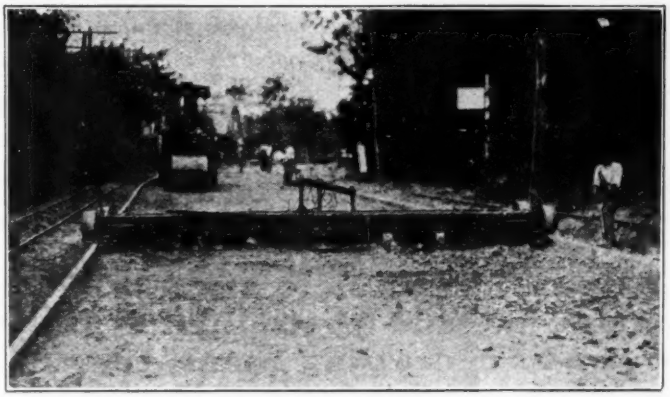

FIG. 9—LAKEWOOD SUBGRADER USED TO SHAPE SUBGRADE AHEAD OF MIXER.

Contracts Awarded

ROADS AND STREETS

Ariz., Phoenix—Twohy Bros. Co., Phoenix, awarded contract for improving portions of Washington St. involving 29,137 sq. yds. paving at $2.92 yd.; 29,233 sq. yds. grading at 30c yd.; 11,048 lin. ft. comb. curb and gutter at $1.50 ft. and incidental items.

Ark., Dermott—Oliver Constr. Co., Litle Rock, awarded contract to build graveled pike from Jerome to Nordman, 9 miles, at betw. $100,000 and $150,000.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick St., Los Angeles, awarded contract for paving with conc. 5.78 miles on Reward Rd., from McKittrick, northwest in Rd. Imp. Dist. 15, at $288,700.

Cal., Los Angeles—W. D. McCray, 424 Am. Bank Bldg., awarded contr. for impvt. of Coringa Drive at $36,796; E. A. Baker, 833 Edgemont St., awarded contract for improving Fountain Ave. bet. Hyperion and Sanborn Ave. at $5,049; Geo. R. Curtis, 2440 E. 26th St., awarded contract for impvt. of 2nd St. at $3,636; S. M. Kerns, 1076 Cerritos Ave., Long Beach, awarded contract for constr. of 5.77 miles Harbor Truck Blvd. at $81,664; A. E. Burns, 407 H. W. Hellman Bldg., awarded contract to grade, gravel and oil streets; also constr. cem. curb, walk and gutter in 60-acre tract now being subdivided bet. Santa Barbara Ave. and 39th St.

Cal., Los Angeles—E. L. Garretson & Son, 1346 Fairfax Ave., awarded contract for paving with conc. Firey Ave. from Covina Blvd. to Foothill Blvd., about 1 mile, Rd. Impvt. Dist. 172, at $16,000; Geo. R. Curtis, 2440 E. 26th St., awarded contract for improving 5th St. bet. Norton Ave. and 132 ft. west, at $1,662; G. T. McLain, 1184 N. Berendo St., awarded contr. for improving Merwin St. betw. Marathon and Kent, at $5,041; V. C. McLain, 227 E. Diller St., Watts, awarded contract fro grading and constructing cem. curb, walk and gutter on Alma St. —st St. to Mich. Ave., Rd. Imp. Dist. 202, at $3,745; S. M. Kerns, 1076 Cerritos Ave., Long Beach, awarded contract for grading, and constructing disint. granite base and culverts and bridges on 5.77 miles Alameda St. bet. Compton and Wilmington, at $81,664.

Cal., Sacramento—Lee Moor Constr. Co., 402 Two Republics Bldg., El Paso, Tex., awarded contract for paving with conc. 7.4 miles Coast State Hwy., Los Angeles Co., betw. Las Flores Canyon and Santa Monica, at $206,739.

Cal., San Bernardino—W. D. Bohan, awarded contract for paving 2nd St. from Carter to K Sts. and on portion of K St., about 28,809 sq. ft., with 4-in. conc. at 17.2c sq. ft.; E. W. Seccombe, awarded contr. for paving 16th St. from B to E Sts. about 73,548 sq. ft. with 4-in. conc. at 16.7c sq. ft.

Fla., Daytona—Atlantic Bithulithic Co., Richmond, Va., awarded contract to construct 120,000 sq. yds. paving and sewers. $100,000.

Fla., Live Oak—J. Y. Wilson, Jacksonville, awarded contract for road work at $255,033; Clayton and Mitchell, awarded contract for various drainage and construction projects for approx. $100,000.

Fla., Tallahassee—Following contracts let for road work: Clayton and Mitchell, Thomasville, Ga., awarded contracts on fed. aid projects 11, 21, 22, 23 and 24 which involve draing. structs, covering abt. 50 miles road in Duval, Nassau, Baker and Columbia counties at total cost of $9,968; also contr. for draing. constr. on projects 26 and 32 covering 21 miles thru Columbia and Alachua Cos., at $47,322; Luten Bridge Co., York, Pa., contrs. for draing. constr. on proj. 33, 12½ miles, at $26,534, in addn. to awards for other drainage structs. in Volusia county from DeLeon Springs to Putnam Co. line, at $26,219; Florida Engrg. & Constr. Co., Oviedo, contr. for draing. constr. on proj. 18, nearly 13 miles, at $19,789; J. D. Donahoo, Perry, contr. for excavation of draing. canals at Choctawatchee River brdg. at $32,000; W. P. Kennedy, Quincy, contr. for timber brdg. near Lloyds, Jefferson Co. at $3,837.

Fla., Tarpon Springs—J. B. McCrary Engrg. Co., Atlanta Ga., awarded contract for paving 4 miles of streets, brick, at $236,000.

Fla., Titusville—Maule Paving Co., Ojus, Fla., awarded contract to construct 15 miles of road at $120,000.

Ga., Savannah—City Council let following paving contracts: Pritchard, Raines & Hazlehurst, at $70,000, to pave Dale Ave., 10,946 sq. yds. oil street asph. at $27,940; Houston St. 13,000 sq. yds. conc. at $34,397; 37th St. 4,200 sq. yds. conc. at $9,450; Dixon Constracting Co. at about $5,000 to pave portion of President, Clifford and other streets.

Ida., Ontario—Hauser Constr. Co., awarded contract for 15 miles grading on Oregon Trail Hwy. from point opposite Weiser on Ore. side to Baker Co. line, at $106,000.

Ill., Moline—Victor McLain, E. Moline, awarded contracts for paving 8th and 9th Aves. for dist. of 22 blocks, at $100,896, also paving of Third Ave. to city limits at $11,019. Material to be used is reinf. concrete and work will begin this winter if weather continues favorable.

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Ill., Springfield—Webber & Co., Ionia, Mich., awarded contract by St. Div. of Highways, for constr. of 12.33 miles hard roads in Bureau Co., at $359,906.

Ill., Springfield—N. C. Finley Constr. Co., Hoopeston, awarded contr. for constr. of hard road connecting Springfield and Jacksonville, at $273,800 without cement and average cost with cement at $28,500; Shidler Constr. Co., Kankakee, awarded contract for 5.19 miles of roads in Jefferson Co., at $22,337 per mile without cement or $116,139 for job.

Ind., Terre Haute—Carpenter Construction Co. awarded contract for constr. of road (Charles F. Hill Road). Est. cost of work $130,000. Work will start in spring. Type: brick.

Ky., Frankfort—Following contracts for road work let by State Rd. Department: Ohio River road contracts, McCracken and Livingston Cos., (in former 2 4/10 miles Kentucky rock asph.) to M. E. Stone & Co., Madisonville, at $26,621; Smithers, Ellis and Costellow, Knoxville, Tenn., contr. for grading and draining 12 miles in latter county, at $58,703; M. E. Stone & Co. contr. for 7 miles in Trigg and Christian Cos. at $81,095. Road is to have gravel surface.

Ky., Hopkinsville—State Hwy. Comn., Frankfort, let contract to M. E. Stone & Co., Madisonville, Ky., at $81,095 to improve 7 mile sec. of Cadiz-Hopkinsville Rd. Christian and Trigg counties.

Mich., Marquette—G. P. Scharl, Muskegon, awarded contract for grading and draining constr. of 11½ miles Baraga Trunk Line St. Rd. 35-5C, Ishpeming Twp., at $175,387.

Mo., Monticello—W. A. Ross, Kansas City, Mo., awarded contract for constr. of 8.37 miles State Rd. from Canton southward and westward, Lewis Co., FAP 38, at $85,827.

Mo., St. Joseph—Moritz & Oren, Effingham, Ill., awarded contract for 6.639 miles St. Rd. from St. Joseph to Dearborn, Buchanan Co., FAP 180, at $211,550.

N. M., Santa Fe—Following contracts let by State Hwy. Comn.: W. T. McClure, Magdalena, N. M., awarded contract for FAP 57, Chaves Co., 14. 242 miles, at $44,350, exclusive 10% for contingencies for engrg.; J. V. Stryker Constr. Co., East Las Vegas, N. M., awarded contract for FAP 63, Curry Co., 13,024 miles, at $87,445, exclusive of 10% for engrg. and contingencies.

N. C., Bayboro—Union Paving Co., Phila., Pa., awarded contract to construct 12.03 miles roadway in Pamlico Co. from Craven Co. line to Bayboro, at $263,022.

N. C., Charlotte—Blythe Bros. awarded contract to pave 14 miles of streets at about $525,000.

N. C., Graham—Elliott-Sholes Co., Durham, awarded contract by State Hwy. Comn. for constr. of 5.22 miles hard surface road from Trollingwood to Orange Co. line, Topeka surfacing on concrete base, project 564, Alamance Co., at $140,115; also contract at $334,294 for 11.70 mi. hard surf. rd. from Gibsonville toward Greensboro, Topeka surfacing on conc. base, proj. 532, Guilford Co.; also contract in conjunction with R. E. Boggs, Spartanburg, S. C., for constr. of 10.24 mi. hard surf. rd. from Lexington to Rowan Co. line, Topeka surfacing on conc. base, proj. 525, Davidson Co. at $292,958.

N. C., Goldsboro—Union Paving Co., Philadelphia, Pa., awarded contr. to constr. 10.01 miles roadway, Wayne Co., from Goldsboro to Lenoir Co. line, at $268,357.

N. C., New Bern—Union Paving Co., Phila., Pa., awarded contract to construct 9.93 miles roadway, Craven Co., from New Bern toward Morehead City, at $246,078, and $16,609 for structures.

N. C., Newton—Union Paving Co., Philadelphia, Pa., awarded contract for 10.85 miles hard surf. road in Catawba Co. betw. Newton and Burke Co. line, at $322,040; Topeka with conc. base, proj. 622.

N. C., Raleigh—Contracts for a million dollars worth of hard surfaced hwys. constr. in 4 counties let by State Hwy. Comn.: work in Wayne (10 miles Topeka asph.), Craven (10) and Pahlico (12) will be done by Union Paving Co., Philadelphia; West Construction Co., Kinston, will build road in Greene Co. (6.7 miles).

N. C., Snow Hill—West Construction Co., Kinston, N. C., awarded contr. to construct 6.81 miles roadway, Greene Co., at $196,446.

N. C., Statesville—R. M. Hudson Co., Salisbury, awarded contract for 10.59 miles hard surf. road in Iredell Co. betw. Shepherd and Statesville, Topeka surfacing on conc. base, proj. 639, at $332,544; structures to Luten Bridge Co., Knoxville, Tenn., at $19,181.

N. C., Washington—P. G. Ligon & Co., Baltimore, and Robt. G. Lassiter, Oxford, N. C., awarded contracts to constr. brick and sheet asph. paving, 30,000 sq. yds., at $197,000.

Okla., Bartlesville—Hamilton Construction Co. awarded contract to construct 25,000 sq. yds. conc. pavement at $100,000.

Okla., Bartlesville—Bartlesville Construction Co. awarded contr. for paving 12 streets and 24 alleys, at $91,500.

Okla., Okmulgee—A. M. Ammerman, Wichita, Kans., awarded contr. for constr. of an 18-ft. road so. from Okmulgee to Henryetta, 12 mi., at $411,000.

Okla., Pauls Valley—Standard Paving Co., Tulsa, awarded contract for paving N. Pine St. at $72,671.

Ore., Baker — Copenhagen Brothers, local awarded contract for bldg. river section of Baker-Cornupopia Rd., at $105,641 (13.2 miles).

Ore., Portland—Following contracts let by State Hwy. for road work: McAuliff & Healy, Portland, $16,395 for grading 7.8 miles Cow Canyon sect. Dalles-Claif. Hwy. Wasco Co.; Bauer & Bauer, Dayton, Wash., for grading and macadamizing Sherman Valley section Sherman Hwy. at $61,-218.50; Bauer & Bauer, grading and macadamizing 7.5 miles Moro-Sherman Hwy. at $65,397.

S. C., Beaufort—J. T. Blassingame, Greenville, awarded contract for grading and foundation work on 20.781 miles Beaufort to Pocotaligo Hwy. at $84,295.

Tenn., Knoxville—Murray Constr. Co. awarded contract for paving Churchwell, Tarleton Sts. and alleys, at $100,000.

Tex., Big Springs—Womack Constr. Co., McKinney, awarded contr. for constructing 34.25 miles gravel road on State Hwy. No. 1 at $250,744.

Tex., Breckenridge — Womack Constr. Co. awarded contract for constr. of Bankhead Hwy. in Stephens Co. at about $1,000,000 for stretch of road.

Tex., Edinburg—W. L. Pearson & Co., Houston, awarded contract to constr. 33.9 miles gravel and caliche rd. from Edinburg no. to Brooke Co. line at approx. cost of $200,000.

Tex., Marshall—F. P. McElrath, Corsicana, awarded contract for finish Jefferson Hwy. No. 11 at $114,274.

Tex., Midland—Womack Constr. Co., McKinney, awarded contract for constructing 26.91 miles gravel road on State Hwy. No. 1, at $205,704.

Tex., McKinney—D. H. Purvis, Ft. Worth, Tex., awarded contract to surface 25 miles of road, rock base and gravel top, at $66,000.

Tex., Odessa—Womack Constr. Co., McKinney, awarded contract for constr. of 24.74 miles gravel road on State Hwy. No. 1, at $209,355.

Tex., Palestine—Gulf Bituluthic Co., Houston, awarded contract by City Council for paving and street impvts. $250,000 bonds sold recently. Total amount of paving to be done here, $750,000.

Tex., Pecos—W. E. Hamilton awarded contract for constr. of protion of Bankhead Hwy. from abt. 2 miles west of Hermosa thru Toyah to Reeves Co. line near Kent, at $107,471.

Tex., Sherman—T. J. Larkin & Sons, Dallas, Tex., awarded contract to construct gravel roads in Gunter, Howe and Southmayd Dists. at about $500,000.

Tex., Stanton—Womack Constr. Co., McKinney, awarded contract for constructing 12.79 miles gravel road on State Hwy. No. 1 at $93,898.

Tex., Waco—McCall-Moore Engrg. Co., Waco, awarded contract to pave Mary St., vitr. brick, $90,000.

W. Va., Charleston—Monongahela Construction Co., Fairmont, W. Va., awarded contract to Proj. 3010, Mineral Co., 10.35 miles northwestern turn-

pike, grading and draining only, at $70,628; Chas. Spindler, Kingwood, W. Va., contract for Proj. 3003, Monongalia Co. 4 mi. Fairmont to Morgantown, grading and draining only, at $62,479; Ronedy Constr. Co., Parkersburg, W. Va., awarded contract for Proj. 3005, Wood Co. 3.5 miles Parkersburg-Williamstown pike, grading, draining and paving with concrete, at $94,936; Newark Paving and Construction Co., Newark, O., awarded contract for Proj. 3073, Ohio Co. 2 mi. National Pike, grading, draining and paving at $77,020; Hunt-Forbes Constr. Co., Ashland, Ky., awarded contract for Project 112, Putnam Co., grading, draining and paving 6.45 miles Midland Trail betw. end of Proj. 45 and point near Kanawha Co. line, bitum. penetration macadam, at $193,115; J. M. Randish & Co., Huntington, W. Va., awarded contract for Proj. 3100, Gilmer Co., 2 miles Glenville-Weston pike, grading and draining only, at $26,776; A. L. Kickolich, Fairmont, W. Va., contract for Proj. 3004, Marion Co., 1.7 miles Fairmont-Morgantown Rd., grading and draining only, at $14,037; Kenedy Constr. Co., Parkersburg, W. Va., contract for Proj. 3040, Fayette Co. 6.8 miles Midland Trail, Longacre to Kanawha Falls, grading, draining and paving with bitum. penetration macadam at $213,916; C. S. Waugh, Williamson, W. Va., awarded contract for grading, draining and paving Proj. 3042, Kanawha Co., St. Albans to Putnam County line, 2.6 miles Midland Trail, bitum. macadam, at $100,382.

W. Va., Wheeling—Newark Paving and Constr. Co. awarded contract for paving 4 miles of National Pike so. of West Alexander, at $77,020.

W. Va., Wheeling—Kennedy Constr. Co., Parkersburg, awarded contract for National Pike, Ohio Co., at $73,639.

Wash., Seattle—J. L. Smith, Pioneer Bldg., awarded contract for paving 15th Ave., N. W., at $188,934.

SEWERAGE AND SEWAGE TREATMENT

Cal., E. San Diego—Hickey & Harmon, 58 2nd St., San Francisco, low bidder and will probably be awarded contract for constr. of 29 miles of sewers for E. San Diego at $232,742.

Cal., Madera—W. J. Tobin, 527 Santa Rey Ave., Oakland, awarded contract for constructing vit. pipe sewer system, approx. 36,000 ft. and sewage pumping plant, at $39,985.

Ont., Hamilton—Following contracts for sewer construction awarded: Wellington St. Sec. No. 1 at $181,198 and Sec. 2 at $174,261 to A. Cope & Son; small sewer on Wellington St. to J. J. Armstrong & Sons at $689.

Fla., Sarasota—J. W. Crawford awarded contract for $16,164 bonds, less 15% for cash, making cash bid $13,740.

Ida., Caldwell—Morrison-Knudsen, Boise, awarded contract for construction of combined drainage and sewer system for North Caldwell at $50,485.

Ia., Dubuque—Even-Ulrich-Staner Co., 446 Garfield Ave., Dubuque, awarded contract for constr. of sewer impvts. in no. sect. of city at $30,000.

Minn., Albany — Hammen & Co., Mankato, awarded contract for san. sewerage system, including disposal plant, at $25,519.

Minn., Rochester—Following contracts let for sewers: Secs. 1, 2 and 3 to Mankato Constr. Co., Mankato, approx. $42,000; Secs. 4, 5, 6 and 7 to Wm. C. Fraser, 810 Guardian Life Bldg., St. Paul, at approx. $26,000.

Minn., St. Peter—Lars Overn, St. Peter, awarded contract for constructing Walnut-5th-Cedar Sts. sewer at $19,000.

N. C., Charlotte—Myers Constr. Co., Meridian, Miss., awarded contract to constr. storm sewers; Tucker & Laxton, Charlotte, contract to constr. sewers in unimproved portion of city at $36,836. Total cost of system, $100,000.

Okla., McAlester—Jno. W. Roos awarded general contract for sewers at $31,752.

Pa., Reading—J. M. Davenport and E. S. Fry (both of Chester) awarded contract for about 6 miles of house sewers in northeast section at $70,000.

Tenn., Memphis—Moreno-Burkham Constr. Co., St. Louis, Mo., awarded contract to construct Binghamton san. sewer outlet main at $56,815.

Tex., Dalhart—Gordon Constr. Co., Denver, Colo., awarded contract to construct sewage disposal plant and extend sewer system at $22,765.

Wn., Seattle—Fiorito Bros., 650 6th Ave., Northwest, awarded contract for installing sewers in E. 70th Street et al. at $52,237.

Wn., Spokane—Standard Asphalt & Paving Co. awarded contract for Fifth Ward Sewer No. 13 at $61,600.

Wis., Valders—W. O. Baer, Manitowoc, Wis., awarded contract for sewerage system at $50,000.

WATER SUPPLY AND PURIFICATION

Ariz., Tucson—Corbett Hardware Co. awarded contract at $22.15 per cwt. for furnishing city with 2,500 ft. 2-in. water pipe f. o. b.

B. C., Burnaby—Paige-Horsey Co., Toronto, Ont., awarded steel contr. for water works extensions at $29,795.

N. S., Halifax—Steel, brickwork and plumbing contracts for pumping station costing $6,100 awarded to MacKinnon Steel Co., Ltd., Drummond Rd., Sherbrooke, Que., and Briggs Constr. Co., Metropole Bldg., Halifax, and Mitchell and McRae, 29 Grafton St., Halifax.

Ont., Mille Roche—Kyer & Scott, Mille Roche, have general contract for constr. of "Eastman" drain at $10,000 for Cornwall Twp.

Que., Montreal—Ross & Grieg, agents for Goldie McCulloch Co., Ltd., awarded contract for 12-million gal. elec. pump for the McTavish St. reservoir station at $16,842.

Que., St. Lambert—Contract for conc. pipe for town awarded to Independent Concrete Pipe Co., Ltd., Huron street, Woodstock, Ont. Contract for laying pipe and san. sewers awarded to Leger, 76-A Rird Ave., and Tardiff, 60 Adams St. Project will cost $53,000.

Iowa, Stanton—Dunnegan & Briggs, Shenandoah, awarded contract for extension of municipal water works at 28c per ft. for excav., backfill and laying pipe. Abt. 7,200 ft. of 4-in. cast iron pipe line, including 8 hydrants, 11 valves and boxes and specials, totalling 79 4-in. and 13 6-in. bells.

Kans., Parsons—Following contracts let: American Cast Iron Pipe Co., Birmingham, Ala., contract for Sec. No. 2 (cast iron pipe) at $127,200; Ludlow Valve Co., Kansas City, Mo., contract for hydrants and valves at about $4,543.

Mass., Boston—National Water Main Cleaning Co., Inc., awarded contract for cleaning water pipes in N. Beacon St. Wash., etc., at $3,680.

Mich., Grand Rapids—The Owen-Ames-Kimball Co. awarded contract for concrete work on new municipal filter plant at $174,691.

Minn., Cloquet—Pastoret Constr. Co., 303 Sellwood Bldg., Duluth, awarded contract for water mains, well, pumphouse, build power line, install pump and motor, at $21,886.

Minn., McKinley—Mr. Pearson, Ely, awarded contract for constr. of new pumphouse at $2,138.

Minn., Forest Lake—F. G. Bauer, Forest Lake, awarded contract for well and pumphouse at $7,321.

Neb., Lincoln—Following contracts let for water works equipment: Boilers to Murray Iron Works Co., Burlington, Ia., two 500-h.p. tubular, $21,300; Coal handling equipt., Jeffrey Mfg. Co., coal conveyor, crushers, $18,650.

Neb., Lincoln—A. A. Dobson Co. awarded contract for work in Water Dist. 11, at $19.975; Knudson and Bruce awarded contract for Water Dist. 23, Northside Ave. bet. 15th and 17th Sts, at $1,182.

O., Cleveland—Stange & Walsh Co. awarded contract for 125.000,000-gal. conc. reservoir on Baldwin Road, at $1,824.

S. D., Madison—Ole Helmey, Madison, awarded contract for diffing and refilling approx. 1,800 ft. water main ditches at 18c per running ft.

Tex., Edinburg—Gulf Machinery & Ship Supply Co., 2128 Strand, Galveston, Tex., awarded contract by city to construct water works and power house, erect 60,000-gal. capy. tank with pump supplying 150 gals. per min., approx. cost $5,000; install $2,000 pump; 40x60 ft. dam and power house, wood constr., conc. floor, cost $16,000, 1 mi. transmission.

S. D., Mobridge—Pittsburgh-Des Moines Steel

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—Bars, Reinforcing
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—Bodies, Dump Truck
—Brick Rattlers
—Catch Basin Covers
—Cement Testing Machinery
—Clam Shell Buckets
—Contraction Joint
—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
—Gasoline Locomotives
—Gravel Screener
—Heaters, Asphalt
—Heaters, Tar
—Hoisting Engines
—Industrial Cars
—Industrial Track
—Manhole Covers
—Mixers, Building
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—Oil Distributors
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—Portable Drilling Rigs
—Pile Drivers
—Reinforcing Steel
—Road Drags
—Road Forms
—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

Co., Tuttle and S. W. 10th, Des Moines, Ia., awarded contract for constr. of water works plant system near Milwaukee bridge, 32,000-gal. capy., $167,850.

W. Va., Mullens—West Va. Engrg. Co. awarded contract to construct water works at $60,000; install 105,000-gal. capy. steel tank.

Wn., Seattle—Schulz Constr. Co., San Francisco, awarded contract for constr. of a distributing sys. for Citrus Heights Irrigation Dist., Northern Sacramento Co., at $163,000. Dist. is comprised of 30,000 acres. Work will consist of principally rehabilitating and enlarging existing system. Main line pipe will be built 5½ miles in length.

Wash., Seattle—Scalzo & Co. awarded contract to install water mains in 39th Ave., S. and Court street, at $1,879; Romano & Rosello Bros. Co., 822 Corwin Place, contracts for water mains in Miller St. at $3,491; also in Harris Pl. et al. at $1,394.

Wis., Taylor—Following contracts let for water works system: Tank and tower to Pittsburgh-Des Moines Steel Co., Tuttle & S. W. 10th, Des Moines, Ia.; valves, hydrants and valve boxes to Iowa Valve Co., Oskaloosa, Ia.; labor to Mierswa Constr. Co., Oshkosh; well to Bowman & McMahon, Durand; c. i. pipe to Am. Cast Iron Pipe Co., 712 Plymouth Bldg., Minneapolis, Minn.

Prospective Work

ROADS AND STREETS

Ala., Clayton—Barbour Co. will construct roads $150,000 bonds voted.

Ala., Tuscumbia—Bids will be asked about Jan. 1st by State Hwy. Dept. for constructing 4 mile hard surf. and 4 mile gravel roads. $225,000 available. A. P. Henderson, Div. Engr., Montgomery.

Cal., Arcadia—City Engr. O. A. Gierlich estimates cost of completing city's streets at $260,000. Paving of important streets will be taken up first.

Cal., Pomona—The $200,000 street impvt. bonds voted in Dec. have been sold at par. Sale of bonds will enable city to start paving campaign comprising abt. 13 miles of streets in business and residential sections. First paving will be done in business dist. City will pay cost of improving 24 streets from bond issue and prop. owners half. Total cost, $400,000. F. C. L. Froedhe, City Engr.

Cal., Sacramento—Expenditure of approx. $15,000,000 for roads in 1922 on state hwy. work mapped out at conference of division engrs. T. E. Stanton, Asst. St. Hwy. Engr.

Cal., San Diego—Petition referred to city manager by Com. Council to pave Penn. Ave.—Front to 5th Sts.—with 4-in. conc. base and one-in. asph. wearing surface. Engrg. Dept. reported to Council prelim. est. of paving and improving Grim and Wightman Sts.: Paving, 180,034 sq. ft.; curbs, 6,805 lin. ft.; curb removals, 5,134 ft.; walks, 6,206 ft.; also plans and specfs. for paving Sunset Blvd. from St. James Pl. to Ft. Stockton Drive. Material is to be Portland cem. conc. base. Prelim. steps taken for paving Roosevelt Memorial Dr. from end of Prospect St. to LaJolla to Biological grade. Council ordered City Engr. to prepare plans and specfs. for this paving. Council also plans to pave Encanto Hwy.

Cal., San Francisco—Board of Pub. Wks. has ordered paving of Columbus Ave. and apporpriated $100,000 for the work. Street will be widened betw. Wash. and N. Point Sts. $128,683 appropriated for constr. of Cliff House pavement.

Ont., Brantford—By-law passed providing for raising $20,000 for purchase of road-making machienry and appliances. H. F. Leonard, City Clk.

Fla., Tampa—Millsboro Co. will repair Bayshore Blvd. and other roads; $100,000.

Fla., West Palm Beach—City will improve streets at cost of $150,000; construct walks, $75,000; also boulevards and parks. $100,000. Bids will be advertised about Jan. 1st, 1922.

Ga., Greensboro—Greene Co. will construct 14 miles of Greene Hwy. from Greensboro to Watson Springs; $300,000 state aid.

Ida., Idaho Falls—Congress will appropriate $1,000,000. This amount, with $2,000,000 made available by sale of hwy. bonds, will be used for impvt. of Idaho-Montana Hwy. and Yellowstone Hwy. in state of Idaho.

Ia., Orange City—Plans being prepared for grading 20 miles of No. Iowa Pike Rd., 191, FAP 22. Est. cost, $200,000.

Kans., Topeka—State Highway Commission will authorize new road projects at once to provide work during winter—plan $4,000,000 highway program. M. W. Watson, State Hwy. Engr. Farmers of Leavenworth County, east of Tonganoxie, are requesting St. Hwy. Comn. to approve constr. of Victory Hwy. from Tonganoxie to east county line at once, so as to provide employment during the winter months.

La., Monroe—Clariborne Parish plans to construct 25 to 35 mi. of highway east and west thru parish from Webster to Union parishes at cost of $200,000. H. C. Diagre, Monroe, Hwy. Engr. in charge.

La., Ruston—Lincoln Parish Police Jury will sell $700,000 road construction bonds.

Mich., Iron Mountain—State trunk line constr. work contemplate 1 mile conc. paving, 20 ft. center of Stepheson Ave. in Iron Mtn. One mile macadam in Norway, road constr work and repairs contemplated for next year. Est. cost, $175,000. Jas. D. Cudlip, Co. Clk.

Mo., Clayton—State Hwy. Dept., Jefferson City, Mo., will construct 7.03 miles State Rd. from St. Louis southward at cost of $283,599; FAP 80; also 6.07 miles State Rd. from Weber Rd. westward, $227, 212; FAP 78, both St. Louis Co. H. D. Griffith, Div. Engr., DeSoto.

Minn., Fergus Falls—Ottertail County will expend $300,000 on road next year. Wm. Lincoln, Aud.

Mo., Jefferson City—If Fed. Aid is granted this state, work will start on highways costing bet. $2,500,000 and $3,000,000. Of this federal aid, portion of cost would be bet. $1,250,000 and $1,500,000. Acting Governor Lloyd reports that projects in seven counties of the state are ready for fed. aid and work can begin immediately in these impvts. if additional aid is granted. Counties and amts. include: Miss., $747,000; Harrison, $500,000; Stoddard, $200,000; Dunklin, $750,000; Buchanan, $200,000, and Jasper, $100,000.

Mo., Marshfield—State Hwy. Dept., Jefferson City, will build 7.733 miles State Rd. from Rogersville eastward. $23,631; Webster Co. State Aid Proj. 20.112. H. P. Mobberly, Div. Engr., Woodruff Bldg., Springfield, Mo.

Neb. Nebraska City—Residents of city plan impvt. of 52 blocks by paving.

Nev., Reno—Federal funds now available for hwy. construction in Nevada amount to $3,246,000. State must match Fed. allotment with $415,000. On Feb. 1st there will be $175,000 available in the highway fund. Total amount available June 1st of next year will be $438,000 or more than enough to match the fed. allotment.

N. M., Santa Fe—State will begin $1,500,000 road constr. program, provided additional fed. aid is made available, as state's share toward relieving unemployment. Governor M. C. Mechem.

Ore., Portland—If prices are right State Hwy. Comn. will award contracts for 120.3 miles of road work of which includes much grading.

Pa., Farrell—Directors of Chamber of Commerce have approved Mercer Co. Bond Issue of $1,300,000 for completion of roads.

S. C., Charleston—$1,000,000 voted for bldg. good highways in county.

Tenn., Memphis—City will widen and pave streets at cost of $2,100,000. Wm. B. Fowler, City Engr.

Tenn., Nashville—Board of Public Works plans paving 10 miles of streets. W. W. Southgate, City Engr.

Tex., Austin—Close to $3,000,000 of aid for hwy. constr. awarded by State Hwy. Comm. at meeting here.

Tex., Boston—U. S. Dist. Engr., Ft. Worth, has approved plans for constr. of 12.3 miles 12-ft. gravel road on Hwy. No. 1 and 8, Bowie Co. Est. cost $165,000. O. B. Pirkey, Co. Judge. Bew Boston; Hess and Skinner, Co. Engr., S. W. Life Bldg., Dallas.

Tex., Ft. Worth—State Hwy. Dept., Austin, Tex., approved plans for surfacing 6.84 miles Hwy. No. 1 from Parker Co. line east with bitum. topping.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

$137,000. Hugh L. Small, Co. Judge; R. V. Glenn, Cons. Engr.

Tex., Mexia—E. L. Dalton, Dallas, Cons. Engr. for Mexia will about 1st of yr. award contracts for considerable paving. $150,000 bonds have been voted.

Tex., Sherman—At public mass meeting citizens indorsed plan for disposing of $190,000 bond issue for constr. of roads.

Va., E. Radford—City will sell $150,000 bonds for purpose of repaving First Street, bldg. sewers, etc.

Wash., Seattle—Road and brdg. impvts. contemplated in Grays Harbor Co. for 1922, according to plans of County Engr. H. S. Shorey, include following: Rd. from Elma to Oakville, 18 miles, is to be rebuilt; rd. from Westport so. to Pacific county line, 8 miles, is to be rebuilt; along no. side Quinault Lake, 5 miles new rd. is to be constructed; from Hoquiam northwest, 13 miles of road is to be rebuilt. All above projects are covered by bond fund voted by county. Numerous other small projects will be taken care of by roads districts and road and bridge funds. 1st undertaking in 1922 King County road program will be stretch of paving 3.69 miles long, 20 ft. in width, est. to cost $120,000. Engr. Beeman expects to advertise for bids soon as weather conditions will warrant. Following the Bellevue-Newport paving will be 2 miles paving on East Valley rd., no. of Pierce Co. line.

Wash., Spokane—Spokane Co. brought 1922 road program to near the $1,000,000 mark when Commrs. voted $140,000 for work on Deer Pk. Hwy.

Wash., Wenatchee—Chelan County is planning extensive program of road impvts. to cost about $500,000. It is planned to finish the 12 miles of pavement betw. Wenatchee and Cashmere on Sunset Hwy.; also lower portion of Blewett Pass Hwy. will be graded and surfaced.

W. Va., Richwood—City will grade and pave road leading from city to Dain along Riverside Dr. on Greenbrief Rd. on roads of upper South Richwood, etc., also construct bridges. Will vote Nov. 29 on $40,000 bonds.

Wis., Juneau—Dodge Co. Bd. voted a $950,000 road constr. program for 1922 under bond issue of $5,-200,000. Following roads are to be constructed: Completion of Waupin-Beaver Dam road, conc.; Randolph-Beaver Dam Rd. work; South Beaver-Dam Rd., conc.; Juneau-Hustisford Rd., 18 ft. conc.; Clyman-Columbus Rd., 18 ft. conc.; Rubicon Rd., conc.; Horicon-Iron Ridge Rd., conc.; Fond du Lac—Milwaukee Rd., conc. E. T. Klug, Juneau, Commr.

Wis., Lake Geneva—County program calls for 32 miles conc. road construction. Concrete rd. from Lake Geneva to Walworth, costing $280,000, and conc. rd. from Lake Geneva to Springfield, as part of the $1,590,000 Walworth Co. rd bldg. program for 1922.

Wis., Madison—Following counties appropriated funds for purchase of road bldg. machy. as follows: Richland Co., $15,000 for rd machy., inculd'g large grader, 6 patrol graders and possibly steam shovel. W. V. Robinson, Richland Center, Commr.; Ashland Co., $10,000, W. E. Dillon, Highbridge, Commr.; Hewaunec, $1,000, Moses Shaw, Algoma, Commr.; St. Croix Co., $10,000, for rd. machy., including heavy grader, wheelers and slips, Joe Caffrey, Hammond, Commr.; Pierce Co., $5,000, C. F. Kenall, Ellsworth, Commr.; Chippewa Co., $8,000, P. O. Lokrantz, Chippewa Falls, Commr.; Eau Claire Co., $20,000, Gay Osborne, Eau Claire, Commr.; Barron Co., voted to purch. gravel crusher, tractor, graders, trucks and other tools for 1922, Ed. Gleason, Barron, Commr.; Price Co., $14,000, for grav. rds. and $10,095 for fed. aid projs. on St. Trunk 13, Westboro-Prentic Rd., B. W. Griffin, Co. Hwy. Commr.; Lincoln Co. Bd. $400,000 for hwys. and bridges in county for 1922, H. H. Kuehling, Co. Hwy. Commr., Merrill.

Wisconsin—Road Machinery: (Lancaster) Grant County Board appropriated $13,500 for equipping county repair shop with machine tools and for petroleum machinery. Henry Mink, Commr.; (Green Lake) Green Lake Co. Bd. approp. $18,000 for equipp'g co. repair shop with mach. tools and for gravel loaders & crushers. D. C. Williams, Commr. Green Lake; Trempealeau Co. Bd. appropriated $20,000 for purch. large grader & tractor and other rd. mach. E. F. Rotering, Commr. Whitehall; Taylor Co. Bd. approp. $15,000 for purch. of various kinds rd. machy. C. Keinhofer, Commr., Medford; Jefferson Co. Bd. approp. $13,000 for purch. of new rd. machy. R. D. Royce, Ft. Atkinson; Adams Co. Bd., $1,000 for purch. of rd machy. J. A. McGregor, Friendship; Clark Co. $13,000 for purch. of screen'g plant, small crusher, scarifier and tractor. Otto Weyhmiller, Neillsville, Commr.; Columbia Co. Bd., $35,000 for purch. of rd. machy. J. T. Henton, Court House, Portage; Pepin Co. voted $1,500 for rd. machy., Gale A. Goes, Durand, Commr.; Vernon Co. Bd. approp. $3,100 for new rd machy. Alex. Ristow, Commr., Ciroqua; Price Co. Bd. appropriated $8,000 for purch. of crusher, tractor, graders and wheelers for 1922, B. M. Griffin, Commr., Phillips; Douglas Co. Bd. $15,000 for new rd. machy.; Winnebago Co. $5,000 for new rd. machy., including one paver, Jas. Binning; Oshkosh Co. Bd. approp. $90,000 for purch. of rd. machy., includ'g crusher outfit and other equipt., W. F. Meyer, Shawano, Commr.; Fond du Lac, Wis. Co. Bd., Fond du Lac County, voted to purch. dragline, conveyer, grizzley, bins and screen for gravel plant, Geo. Treleven, Fond du Lac, Commr.; Lincoln Co. Bd. voted $10,000 for purch. of rd. machy., including patrol graders and other small equipment, H. K. Kuehling, Merrill, Commr.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Los Angeles—Plans completed by City Engr. Jno. A. Griffin, for the constr. of the proposed Arroyo de la Sacatela storm sewer sys., which will necessitate laying 37 miles pipe lines. Est. cost $2,500,000. Actual work of installing the system will start about Feb. 1st if everything runs smoothly and proj. is not delayed by reason of majority protest, which is not likely, as absolutely necessity of impvt. is generally acknowledged by the people. System will be established in northwestern section of city. Pipe will vary in size from 18 ins. in diam. to an outfall conduit 11 ft. high and 20 ft. wide.

Cal., Piedmont—$65,000 bonds voted here for constr. of an outlet sewer from lower Piedmont to estuary.

Cal., Richmond—San Pablo sanitary district is being formed to carry out establishment of sewer system for all the north environs of Richmond, the fall of which is toward San Pablo bay.

Cal., San Diego—Engr. Dept. preparing plans for 10-in. sewer to be built down Powder canyon thru Balboa park. New sewer is intended to provide sewerage facilities for large territory no. of park that is now served only by septic tanks.

Ont., Brantford—City Council intends to construct storm sewers in various streets at estimated cost of $30,694. City Clerk, K. F. Leonard.

Ont., Hamilton—Constr. of sewer at cost of $150,-000 in Paradise Rd. from King Street for 2,000 ft. north, is being considered by City Council. E. C. Gray, Engr.

Ont., London—Bd. of Works recommended to City Council the constr. of a $200,000 storm sewer system to serve the Pine Lawn survey of Housing Comn. Bd. will also ask City Council for $130,000 for sewers in vicinity of Duchess Ave. and Emery St., So. London. Plans being prepared for another $271,000 storm sewer system for High St. Dist., work on which will start in spring. City Engr., H. A. Brazier.

Fla., Dunedin—Sewer and street impvt. work planned for Dunedin will call for expendt. of more than $100,000. Geo. S. Iredell, Tampa, Engr.

Fla., Inverness—$75,000 sewer and water bonds voted; constr. 5 miles sewers and 5 miles water works.

Fla., Lakeland—City plans to extend sewer system including additional sewers at cost of $144,000. C. D. Mendenhall, City Engr.

Ida., Coeur D'Alene—Council has ordered installation of sewer system in northern section of city. Est. cost, $100,000.

Ky., Ashland—(H. R. Dysard, Mayor) will install and extend sewers. $250,000 bonds voted.

Ky., Paducah—City will construct trunk line sewers, install laterals and drains in Dist. No. 3. $600,000 bonds voted. Alvord and Burdick, Cons. Engrs., Chicago, Ill. F. W. Katterjohn, Mayor.

Mass., Andover—Bldg. of sewers is planned here. Abt. $250,000. Engineer not announced.

Mo., Joplin—Following appropriation of $25,000 by City Comn., City Engrg. Dept. announces that work will begin on the $35,000 Turkey Creek septic tank as soon as weather is favorable. Urias Johnson,

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
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East Iron & Machine Co., The
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Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
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The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
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Warren Bros. Co.

Portable Stone Bins.
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Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Asst. City Engr. will have charge of the constr.

N. J., Newark—Engineers are urging Passaic Valley Sewerage Comn. to apply to War Dept. for permission to use Newark Bay as temp. outlet for trunk sewer, and ask that $2,000,000 be appropriated for completion of outfall work to Robin's Reef in New York Bay.

N. C., Enfield—City will expend $190,000 to construct sewerage, water and elec. lighting systems. Wm. C. Olson, Cons. Engr.

N. C., Mount Holly—City will expend $95,000 to install sewer and water systems. Carolina Engrg. Co., Engrs., Wilmington, N. C.

Okla., Devol—City will construct sewer system. $50,000 bonds issued.

Pa., Harrisburg—State health authorities have approved plans for extensions of sewers systems in W. Chester, Sayre, Carlisle, Charleroi, Grove City, New Castle, Youngsville, Sewickley and Carnegie.

Pa., Phila.—Plans drafted by Dept. Pub. Wks. for constr. of 8 main sewers; $920,000 available for project.

S. C., Charleston—City will purchase and establish sewer system. $500,000 bonds voted.

S. C., Greenville—City considering enlarging sewer system; plans voting on $100,000 bonds.

Tex., Brownsville—$75,000 bonds voted for constr. of sewage disp. plant here. Bids in Feb., 1922. J. A. Spencer, City Engr.

Tex., Fort Worth—$725,000 sewage disposal plant will be constructed here. Hawley & Sands, Ft. Worth, Engrs.

Va., East Radford—City will sell $150,000 bonds to construct sewers, repave streets, etc.

Va., Richmond—Mayor Ainslie approved resolution providing for construction of sewer; $200,000 available for impvts.

Va., So. Norfolk (Norfolk P. O.)—City will improve sewer system and streets. $300,000 bonds voted. F. L. Rowland, Mayor.

Wis., LaCrosse—Plans completed for trunk sewer and laterals in 16th St. from Mississippi to Green Bay Sts., lats. on Johnson, Adams and Hood Sts. City Engr., Geo. F. Bradish. Abt. $88,000. City Clk., M. Birnbaum.

Wis., Plymouth—City will issue $36,883 bonds for sewage disp. sys. Jerry Donahue Engrg. Co., Sheboygan, will prepare plans this winter.

WATER SUPPLY AND PURIFICATION

Ont., Almonte—Plans will be prepared for water works system to cost $300,000 for town. James, Proctor and Redfern, Ltd., Cons. Engrs., Excelsior Life Bldg., Toronto.

Ont., Petrolia—It is proposed to install elec.-driven pumps at pumphouse at Lake Huron and to constr. million-gal. auxiliary reservoir for town. Est. cost $42,000. James, Proctor & Redfern, Engrs., in charge of work. Constr. will commence early in 1922.

Fla., Tallahassee—Prelim. surveys for extensive hydro-electric plant, to be established on Ocklocknee River, 12 miles no. of here, started by corps of experts under direction of Guy Winthrop.

Ga., Atlanta—City will offer for sale bonds totaling $8,850,000 which consist of four items: Schools, $4,000,000; water works, $2,850,000; sewers, $1,250,000, and Spring St. viaduct, $750,000. In water works department impvts. will consist of following: Intake basin at river from which water will be taken, mud allowed to settle before water is pumped to Hemphill station; 48-in. main from river sta. to Hemphill sta., present equipt. being 30-in. and 36-in. main; additional pumps at river sta.; enlarged coal storage facilities and automatic stokers and enlarged boilers at both stations; enlarged boilers at both stations; enlarged distribution sys. thru city, enlarged filter plant at Hemphill station and enlarged clear water basin at Hemphill station.

Kans., Pratt—Benham & Mullergreh, Cons. Engrs., Kans. City, Mo., retained by City as Cons. Engrs. for development of new water supply and extensions and impvts. to water plant and system. Est. cost $100,000. N. S. Young, City Clk.

Ky., Hazard—City will install water works. $75,000 bonds voted.

N. C., Mt. Holly—City will expend $95,000 to install water and sewer systems. Carolina Engrg. Co., Engrs., Wilmington, N. C.

Okla., Chickasha—City will extend water and sewer systems. $50,000 bonds voted. Jno. C. Milliken, City Engr.

Okla., Hobart—Water works bonds voted here in sum of $110,000 and sewer bonds $12,000—total of $122,000.

Okla., Okla. City—In order to put sewer system into operation it is proposed to lay 22 miles of 6-in. water mains and one mile 3-in. mains. Est. cost $210,000. Valves and special attachments will cost approx. $61,000. New fire hydrants approx. $9,792. A. S. Holway, Supt. Water Dept.

Okla., Tulsa—City Comn. plans to improve Spavinaw water supply project; will constr. 50-ft. dam on Spavinaw Crk.; 55-mile conduit furnishing daily maximum supply of 25,000,000 gals. to connect water by gravity to point 5 miles from city; erect high pressure distribution pumping station to lift water 300 ft. to high pressure distribution reservoir; construct Tiawah Tunnel. J. D. Trammell, Cons. Engr., Ft. Worth, Tex. (Holway Engrg. Co., 332 Atco Bldg., Tulsa; Pres., W. R. Holway.)

Ore., Portland—Water Dept. considering constr. of 1st unit of proposed third pipe line from Bull Run headwks., 30 miles east of Portland, to reservoirs at Mt. Tabor. Completed pipe line, estimated to cost $2,000,000. Fred M. Randlett, Chf. Engr. Water Bureau.

Pa., Harrisburg—State health authorities have approved plans for impvt. of water systems in Bolivar, New Kensington, Du Bois, Indiana, Freeport and Downingtown, Penn. New Holland authorized to add 2 springs to town's water supply.

Tenn., Memphis—Geo. W. Fuller, of Fuller & McClintock, Cons. Engrs., New York City, retained by Water Comn. to make survey of available water supplies in city. Work will be done prior to extensive impvts., contemplated in Memphis artesian water system and for which bond issue of $2,000,000 was authorized by last legislature. F. G. Proutt, Chrmn. Water Comn.

Tex., Cameron—City Council has accepted report of J. D. Fowler of the Engineers' Serv. Corp, Dallas, on probable cost of new water and light plant for city, also sewerage exten. and sewage disposal plant. Est. cost $200,000.

Tex., Cleburne—City Water Comn. (Mr. Hockaday, Supt.) will improve water works; plans impounding Brazos River for permanent water supply. Burns & McDonnell, Engrs., Kans. City, Mo.

Tex., Coleman—City (E. P. Scarborough, Mayor) will enlarge water supply; construct reservoir. Vote Dec. 20 on $160,000 bonds. W. E. Dickerson, Engr.

Tex., Corpus Christi—City will lay 6-in. mains and install fire hydrants in Nueces Bay Heights.

Tex., Gatesville—Election carried for issuance of $425,000 bonds; funds to be used for bldg. adequate water sys. or purchasing and improving the one now in operation.

Tex., Greensboro—City (P. C. Painter, City Mgr.) will expend $300,000 to extend water works; constr. dam and filtr. plant, extend mains.

Tex., Marlin—City will install water works, construct reservoir, standpipe and mains. L. Goodrich, City Engr.

Tex., Pampa—$80,000 bonds voted here for water works.

Tex., Port Arthur—City will extend water mains. $123,791 bonds voted. E. R. Thomas, Clk.

Wn., Walla Walla—New plans for water works extensions are expected to reach Walla Walla within a few days. W. Craig Ferguson, Commr. of Finance. Ernest B. Hussey, Engr., Seattle, reports plans nearly finished. If received soon it may be possible to open bids about January 1st.

W. Va., Elkins—Work will be started at once on constr. of water and filtr. plant to cost $125,000.

Wis., Cedar Rapids—Will ask bids in Spring for reservoir, Grand Ave. near Bever Ave. Engrs., Holmes & Anthony, 323 Masonic Temple, Cedar Rapids. 226-ft. diam. Election in March on $300,000 bond issue. L. J. Storey, City Clk.

Wyo., Guernsey—Water users of No. Platte Valley authorized constr. of dam and power plant to cost $2,000,000.

BUYERS' GUIDE

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Sanitary Supplies.
Integrity Chemical Co.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.
Littleford Brothers.

Tar and Pitch.
The Barrett Co.

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Trailers.
Lee Loader and Body Co.

Trench Braces.
Kalamazoo Fdry & Mich. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

Turbines, Steam.
De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warranite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Mueller Mfg. Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
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